NORTHEAST FLOOD STUDIES

REPORT

ON

REVIEW OF SURVEY

FOR

FLOOD CONTROL AND ALLIED PURPOSES

ANDROSCOGGIN RIVER BASIN

MAINE AND NEW HAMPSHIRE

IN TWO VOLUMES

VOLUME II

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

15 APRIL 1965

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APPENDIX D

FLOOD LOSSES AND BENEFITS

1. DAMAGE SURVEYS

A detailed damage survey was made in the main flood area of the Androscoggin River following the record flood of March 1936. Later surveys were conducted in 1952, 1961 & 1966 ~~and 1961~~ to obtain more detailed flood damage information in the river basin and to determine trends of development in the watershed. The surveys consisted of door-to-door interviews, and inspections of the various residential, commercial, rural, and industrial properties in the flooded areas. Information obtained included the extent of areas flooded, description of property, the nature and amount of damages, depths of flooding, high water references, and relationships between the March 1936 flood and other flood stages.

Damage estimates and depths of flooding were generally furnished by property owners and tenants, but investigators prepared alternative estimates when in their judgment, based on property examination, estimates of owners or tenants were unrealistic or unreliable. The investigation also made estimates when information was not available from owners or tenants. Where several properties of similar type were subject to the same depth of flooding, sampling methods were used. The review surveys were concerned principally with changes in use of previously surveyed properties, changes in business activities in the larger industrial plants covered in the original surveys and properties new in the flood area since the original surveys.

Sufficient data were obtained to derive loss estimates for (1) the March 1936 flood stage, (2) a stage 3 feet higher, and (3) intermediate stages where marked increases in damage occurred. The stage at which damage begins, referenced to the March 1936 flood stage, was also determined.

2. LOSS CLASSIFICATION

Flood loss information was recorded by type of loss and location. The types recorded include urban (residential, commercial and public), industrial, highway, rural and utilities.

Primary losses were evaluated, including (1) physical losses, such as damage to structures, machinery, equipment and stock and cost of cleanup and repairs, and (2) non-physical losses such as unrecoverable losses of business and wages, increased cost of operation, and the cost of temporary facilities.

Physical losses and a large part of the related non-physical losses were determined by direct inspection of flooded properties and evaluation of the losses by either the property owners or field investigators or both. The non-physical portions of the primary losses were often difficult to estimate on the basis of available information. When this difficulty existed, the non-physical losses were estimated by utilizing determined relationships between physical and non-physical losses for similar properties in the survey and other areas.

No evaluation was made of intangible losses including items such as possible loss of life, hazards to health, and detrimental effects on national security.

3. EXPERIENCED LOSSES

Following the disastrous flood of 1936, a survey of damages was made by field investigators of the Corps of Engineers. The survey disclosed that this flood caused total experienced damages amounting to $4,392,000, of which 96% was in Maine and four percent in New Hampshire. About 40 percent of the experienced loss was to industrial properties. Paper, pulp, and textile mills at Brunswick, Topsham, Lisbon Falls, Lewiston, Livermore Falls, Peru, and Rumford, Maine, and at Berlin, New Hampshire, which are major elements in the economy of the basin, were seriously affected. Urban losses of about $850,000 were experienced, with the major part of this loss being concentrated in the residential and commercial sections of Lewiston, Auburn, and Mexico, Maine. Highways in the basin sustained damages in excess of $700,000 and railroad damages amounted to $450,000. These damages included the loss of bridges which in some cases, have been rebuilt at higher elevations. Public utility properties, principally hydroelectric installations of the Central Maine Power Company, suffered damages amounting to $190,000 with attendant plant shutdown for up to seven weeks. Agricultural losses of $285,000 were experienced, with farms in Lisbon, Canton, Dixfield, Hanover and Bethel, Maine sustaining the major portion of this loss.

The flood of March 1953, the third highest at Rumford since 1892, caused losses totalling $2,230,000 in the entire river basin. Flood damages were experienced throughout the entire length of the main river from Berlin, New Hampshire to Brunswick, Maine, and along three of the principal tributaries, the Dead River in New Hampshire and the Swift and Little Androscoggin Rivers in Maine. Flood waters inundated a great many roads causing highway damages in excess of $150,000 and preventing motor transportation throughout a major portion of the basin for the greatest part of four days. Damages were sustained by industrial properties along the main river of Rumford, Peru, Livermore Falls, Lewiston, Auburn, Lisbon, Topsham, and Brunswick, Maine, and on the Little Androscoggin River at Mechanic Falls. The dam of the Pejepscot Paper Company at Lisbon Falls, Maine was breached. Replacement costs were estimated at $100,000. The Dead River overflowed streets in the business section of Berlin, New Hampshire, causing damages to a number of stores. The Swift River overflowed the main street of Mexico, Maine necessitating the evacuation of some 100 families and closing of the main commercial section of the town. Several railroad washouts occurred along the Androscoggin River in the Canton-Peru area, below Rumford; large areas of agricultural lands were flooded between Gilbertville and Bethel, Maine, and stream banks were eroded at numerous locations throughout the basin.

4. RECURRING LOSSES

Stage-damage and stage-discharge relationships were developed to reflect the magnitude of recurring losses at varying stages of flooding above and below the reference floods in the studied areas. The recurring losses used in development of the stage-damage relationships reflect economic and physical conditions in the areas at the present time.

The recurring loss from a 1936 flood on the main stem of the Androscoggin River from the Sawmill Dam in Berlin to below Brunswick is estimated at ~~$12,457,000~~. Recurring losses by type are listed in Table D-1. $13,703,000

Twenty industrial firms employing over 9,000 persons are located along the river and would sustain substantial damage in the event of a recurrence of the 1936 flood. The industrial activities of these plants produce a diversified line of products including textiles at Lewiston, boots and shoes at Auburn, pulp and paper at Rumford and pulp, paper, and allied products in Berlin.

A summary of total recurring damages listed by damage centers is shown in Table D-2.

TABLE D-1

RECURRING LOSSES BY TYPE

1936 FLOOD
(~~1964~~ Price Level)
1966

Type	Recurring Loss	
Industrial	~~$ 8,057,000~~	$ 8,863,000
Urban (Commercial, Residential & Public)	~~2,442,000~~	$ 2,686,000
Highway	~~996,000~~	$ 1,096,000
Railroad	~~336,000~~	370,000
Utilities	~~565,000~~	621,000
Rural (includes agricultural)	~~61,000~~	67,000
	~~$12,457,000~~	$ 13,703,000

TABLE D-2

RECURRING LOSSES IN DAMAGE AREAS

1936 FLOOD
(~~1964~~ Price Level)
1966

Area	Recurring Loss	
Brunswick - Topsham	~~$ 2,951,000~~	$ 3,246,000
Lewiston - Auburn	~~2,510,000~~	2,761,000
Livermore Falls	~~1,313,000~~	1,444,000
Rumford - Mexico	~~4,168,000~~	4,585,000
Shelburne, N.H.	~~219,000~~	241,000
Gorham - Berlin, N.H.	~~1,296,000~~	1,426,000
	~~$12,457,000~~	

5. ANNUAL LOSSES

Estimated recurring losses along the river were converted to average annual losses by correlating stage-damage, stage-discharge and discharge-frequency data to derive damage-frequency relationships in accordance with standard Corps of Engineers practices. Plates D-1, D-2 and D-3 show the procedure used in converting recurring stage-damage data to annual losses and benefits. Average annual losses by major damage centers are listed in Table D-3.

TABLE D-3

PRESENT AVERAGE ANNUAL LOSSES

(~~1964~~ 1966 Price Level)

Brunswick - Topsham, Me.	$ 160,800	$160,800
Lewiston - Auburn, Me.	~~87,600~~	96,400
Livermore Falls, Me.	~~93,600~~	102,900
Rumford - Mexico, Me.	~~188,000~~	206,800
Shelburne, N.H.	~~3,400~~	3,700
Gorham - Berlin, N.H.	~~137,600~~	164,400
	$ 671,000	735,000

6. FUTURE ANNUAL LOSSES

Flood losses in the Maine portion of the basin can be expected to increase at least as fast as the overall economic growth rate for the area. As discussed in Appendix C, Economic Development, the overall economy in the basin is expected to grow at a rate of 0.75 percent annually for the next 50 years and then remain stable for the following 50-year period. The total growth of 37.5 percent in 50 years was converted to an average annual equivalent value over the 100-year project life by compound interest methods using an interest rate of 3-1/8 percent. The annual equivalent value so derived amounts to 18.6 percent. Average annual losses adjusted for the expected growth amount to ~~$750,000~~ 830,000 at ~~1964~~ 1966 price levels.

7. BENEFITS

a. Tangible Flood Damage Prevention Benefits.

Construction of the Pontook project will reduce flood flows along the entire length of the Androscoggin River from Berlin to tidewater and provide substantial protection to presently flood prone properties. In a recurrence of the record flood of 1936, under today's conditions, the reservoir would prevent ~~$3.5~~ $3.9 millions in losses.

Present average annual flood damage prevention benefits have been derived as the difference in annual losses along the river under present conditions and those that would remain after reduction in flood flows by the reservoir. Average annual benefits so derived for the Pontook project are ~~$190,000~~. $209,000

b. Future Benefits.

When the growth in the Maine portion of the basin over the next 50 years is considered, the benefits at the end of the 50-year period will have grown to ~~$217,600~~ $239,500. Taken as an average annual equivalent value over a 100-year project life, the benefits to growth amount to ~~$14,000~~ $15,000. Total benefits over the life of the project, adjusted for growth, are therefore ~~$204,000~~. $224,000

c. Redevelopment Benefits.

Pontook Dam is to be constructed in a portion of New Hampshire, Coos County, which has been ~~named~~ designated a Redevelopment Area by the ~~Area~~ ECONOMIC ~~Re~~Development Administration under ~~Section 5b(6) of~~ P. L. ~~87-27~~ 89-136. The construction will put to work residents of the area who are unemployed or under-employed and the wages thereto are considered a benefit under current policy. Division records for Civil Works construction over the past 9 years indicate that for the type of construction involved the labor costs average 27% of total contract cost. Based on the present estimated construction cost of Pontook, the total labor cost would be $10,800,000 ~~$9,300,000~~. After discounting for the number of people who will be hired locally (70%) and for the number so hired who will be unemployed or under-employed (75%), a total labor benefit of ~~$5,000,000~~ 5,670,000 is creditable to the project. As this is to be dispersed over a six-year period, the expenditures ~~(for years 2 through 6)~~ are discounted by present worth factors at 3-1/8% interest rate. The discounted value of the benefit is ~~$4,500,000~~ 5,100,000. Amortized over the 100-year project life, the annual benefit amounts to ~~$117,100~~, ~~rounded to $118,000~~. 167,000

d. Intangible Benefits.

In addition to tangible benefits resulting from project construction, important intangible benefits will be realized. Among these are prevention of possible loss of life, prevention of disease caused by flooding of polluted water, and the stabilizing effect on community life in the valley by the reduction in the flood threat.

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15 April 1965

VOLUME II

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DIGEST OF PUBLIC HEARINGS

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DIGEST OF PUBLIC HEARINGS

Public hearings were held in Berlin, New Hampshire and Lewiston, Maine on 13 and 14 December 1960, respectively, to ascertain the needs and desires of local interests for flood control and allied purposes in the Androscoggin River basin. Approximately 50 people attended each hearing, including representatives of Federal, State, city, and town governments, industrial establishments, civic organizations, and interested individuals. A digest of the public hearings and letters relevant thereto is included in this Appendix. Brigadier General Seymour A. Potter, Jr., Division Engineer, was Hearing Officer at each hearing.

DIGEST OF PUBLIC HEARING - 13 DECEMBER 1964

BERLIN, NEW HAMPSHIRE

Speaker	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Mr. Lavier Lamantagne, Mayor	City of Berlin, N.H.	Briefly described the damage to property in the city from floodwaters on the Dead River.
Mr. Arthur J. Bergeron, Attorney	Board of Selectmen Town of Gorham, N.H.	Read Brief from Town of Gorham, N.H. Suggested a flood control dam on Peabody River, and diversion of floodwaters on Moose River to Moose Brook and into a new channel to the Androscoggin River. Submitted summary of flood induced expenses to State and Town for past decade.
Mr. John S. Busby, Asst. Division Engineer	Canadian National Railways (Grand Trunk)	The railroad experiences damage from floodwaters on the Peabody, Moose, and Androscoggin Rivers. All costs and repair of tracks and road-bed are made by the railroad. Dredging the channel of the Androscoggin River, adjacent to the Grand Trunk line, would lessen the flood problem in that area.
Mr. Edward C. VonWild, Shelburne, N.H.	Interested Individual	Reported that debris from city dumps and sawmills, and pulp plug the intake bays of the Shelburne powerhouse. Believed a river patrol should be established to prevent the disposal of debris in the river. If debris is removed from dam so that new gates can be installed and future flushing is possible, odors that occur during warm days in the summer would be eliminated. About 300 feet of the Grand Trunk Railroad tracks in Shelburne are often flooded. Also submitted paper containing suggestions for improvements of the Androscoggin River channel between Berlin, N.H. and the N.H.-Maine boundary line.

Speaker	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Mr. Tony G. Eastman, Berlin, N.H.	Interested Individual	Requests restoration of the deteriorating Pontook Dam. The dam, constructed of wood and located about 15 miles upstream of Berlin, created an excellent fishing and wildlife area.
Mr. Allen I. Lewis, Engineer	N.H. Dept. of Fish and Game	The Department welcomed the opportunity to work with the Corps of Engineers to assure that conservation elements will be considered in the projects as in the past.

LETTERS AND STATEMENTS RECEIVED AT HEARING

BERLIN, NEW HAMPSHIRE

Writer		
Mr. Douglas Horton	Selectman, Town of Randolph, N.H.	Letter, dated 13 December 1960, suggested a flood control dam with water storage for recreational facilities on the Moose River within the geographical boundaries of the town.
Mr. Gerald S. Wheeler, Forest Supervisor	U.S. Dept. of Agriculture, Forest Service, White Mountain National Forest	Statement, undated, indicated a desire to appraise impact of improvements for flood control and allied purposes on the multiple-use program for managing and protecting the resources of the National Forests. In doing this, other agencies will be consulted to determine their desires for the development. Findings will be submitted to the Corps of Engineers for consideration.

Writer	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Mr. Frederick M. Auer, Engineer	N.H. Dept. of Public Works and Highways	Statement, dated 13 December 1960, and made Exhibit E, described flood and high water damage to highway facilities in N.H. portion of the Androscoggin River basin since flood of 1927.

DIGEST OF PUBLIC HEARING - 14 DECEMBER 1960

LEWISTON, MAINE

Speaker		
Mr. Roscoe L. Clifford, Planner	City of Auburn, Maine	Submitted official document "City of Auburn Zoning Ordinance" effective September 14, 1960. Requested it be reviewed for accuracy and for comments.
Mr. Emile Jacques, Mayor	City of Lewiston, Maine	Read statement, undated, calling for action, based on past experience and studies, to rid the Androscoggin River of pollution and make it fit for many uses for both industry and the public welfare. Present operations ordered by the courts have not increased the water quality and there is a lack of suitable water for industry. Have had proportionately too many studies and not enough action. River should be made useful for business, industry, and recreational purposes. Later in the hearing, the Mayor noted that roads in Auburn and Lewiston were inundated by floodwater about every 2 or 3 years.

Speaker	Interest Represented	Improvement Desired, Reasons Advanced, or Other Remarks
Hon. Peter A. Garland, Congressman-Elect	First Congressional District, Maine	Present as an observer.
Mr. Edward H. Brooks, Sr., Auburn, Me.	Interested Individual	Hopes the rivers in Maine will be cleared of pollution. Sometime floods will do this. Describes his process of eliminating the pollution condition.
Mr. John W. Jordon Vice-President and General Counsel	Brown Company Berlin, N.H.	In rebuttal to Mayor Jacques' statement, this speaker asked that the records of the hearing show a great deal has been accomplished by industries to reduce the pollution in the Androscoggin River. The Brown Company has spent almost $6 million directly on the problem. Soon, raw sewage will constitute the major portion of the pollution.
Dr. Walter O. Lawrence	Administrator of Industrial Pollution of the Androscoggin River	Corporations can no longer be blamed for not developing pollution protection. The companies on the river will have spent $20 million by next summer in reducing pollution. By then, the industrial pollution load will be lower than that of domestic sewage and the total load will be minute, as compared with the amount in 1940. (Ed. Note: At this point General Potter re-emphasized the position of the Corps of Engineers on the question of pollution, and the limits of our authority.)
Mr. P. Murphy, Lewiston, Me.	Interested Individual	Will the problem of pollution, by solids, affect the flood control measures taken by the Corps of Engineers. (Ed. Note: Dr. Lawrence stated that he believed the quantity of suspended solids present would not affect flood control works.)

Speaker	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Mr. Ford W. Harris Engineer, Auburn, Me.	Interested Individual	His employer, a railroad company serving a large portion of the Androscoggin River basin, is neither for nor against flood control measures, is interested in plans involving railroad facilities.
Mrs. Robert D. MacPherson	League of Women Voters of Maine	Read undated statement. The organization supports promotion of long range planning for conservation and development of water resources and stresses need for coordinated administration, regional and river basin planning, and equitable financing. While flood control should be considered in multiple-purpose projects, the main problem of the Androscoggin River is pollution caused by industrial wastes and municipal sewage. Maine's record of sewage treatment was the lowest in the nation in 1957 when about 90 percent of the sewered population disposed of raw sewage in the waterways. Maine waterways, now used principally as carriers of waste, should serve for industrial processing, domestic water supply, irrigation, and recreation, and should be free of hazards of disease and odors. There will be more demand for clean water in the next few years. Asked that Corps of Engineers develop plans to maximize use of resources in the basin to provide power, flood control, increased water supply, irrigation, recreation uses, and stream regulation. Suggested that flood plain zoning be investigated as an alternative to flood control facilities. Asked that citizens be given an opportunity to discuss and consider alternative possibilities for the development of the river, and that all agencies whose policies affect the river be coordinated to eliminate duplication.

Speaker	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Mr. Edward C. VonWild, Shelburne, N.H.	Interested Individual	Desires the establishment of a river patrol to prevent the disposal of debris in the Androscoggin River. Wished the engineers would clear the river of garbage. Keeping refuse out of the river will abet passage of water.

LETTERS AND STATEMENTS RECEIVED AT HEARING

LEWISTON, MAINE

Writer		
Mr. Vance A. Lincoln and members of the Androscoggin Lake Committee	Office of Selectmen, Town of Wayne, Maine	Letter, dated 3 December 1960, briefly describes the economic losses to the town from high water on Androscoggin Lake - a summer residential area. Nearly every spring the grossly polluted high waters on the Androscoggin River flow up the Dead River and into the lake, raising the water surface 12 to 15 feet. During the flood of March 1936 the surface rose about 27 feet. Believe a new and higher dam with larger gates on the Dead River would solve the flood problem of the lake.
Mr. E. Boyd Livesay Superintendent	Brunswick and Topsham Water District, Maine	Letter, dated 13 December 1960, reports well field frequently flooded and pumping station inundated in 1936 and 1953. Denotes damages from these floods. Since the Androscoggin River is highly polluted, the hazard of epidemics exists when flooding occurs. Present water supply not adequate to attract new water using industries. Request consideration be given to the control of floodwaters and pollution in the river.

Writer	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Board of Selectmen and Town Manager	Rumford, Maine	Submitted statement and Code Zoning Law. Flooding of public and private properties by the Androscoggin and Swift Rivers has been of great concern to the inhabitants of Rumford and Mexico, Maine for many years. The largest flood occurred in 1936 and the next largest in 1953. Believe the most feasible method of controlling floodwaters is by retarding structures on the tributaries below Errol, N.H. and on the Swift River. Also diversion of floodwaters below Rumford would be of great benefit to the town. Despite the flood improvements made by Rumford, flooding of properties still occur. (Ed. Note: Supplemental letter dated 23 December 1960, requested consideration be given to: removing several river channel obstructions and dredging a part of Wheeler Island, all located on the Androscoggin River in Rumford; and dredging and straightening the channel of the Swift River. These obstructions caused ice jams that increased the height of flood flows.)

APPENDIX B

HYDROLOGY AND HYDRAULICS

APPENDIX B

HYDROLOGY AND HYDRAULICS

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APPENDIX B (cont'd.)

PLATES

APPENDIX B

HYDROLOGY AND HYDRAULICS

1. INTRODUCTION

This appendix presents climatological and hydrological data for the Androscoggin River basin, the analysis of floods of record, the development of synthetic floods, the analysis of various flood control measures, and the determination of flood reductions afforded by various studied flood control projects.

GENERAL DESCRIPTION

2. ANDROSCOGGIN RIVER BASIN

The Androscoggin River basin is located principally in the southwestern part of Maine with part of the headwater area lying in the northeastern part of New Hampshire as shown on Plate No. B-1. Of the total drainage area of 3,450 square miles, approximately four-fifths (2,730 square miles) are in Maine and one-fifth (720 square miles) in New Hampshire. The lake and pond areas comprise about 143 square miles or 4.1 percent of the total area. The basin has a length of about 110 miles and a width of about 65 miles. The average elevation of the terrain is between 600 and 1,500 feet above mean sea level. The upper portions are rough, mountainous and almost entirely covered by forests. The lower portions are hilly, partly wooded and contain considerable cultivated land.

Hydrologically, the basin can be divided into three areas:

a. The area above Errol, New Hampshire.

b. The area between Errol and Webb River, below Rumford, Maine.

c. The area between Webb River and the Mouth.

The upper portion of the basin above Errol, New Hampshire (D.A. = 1045 sq. mi.) includes six lakes with 661,000 acre-feet of combined usable storage capacity. Collectively these lakes are frequently called the Rangeley Lakes. Pertinent data for the Rangeley Lakes is given in Table B-1. The lake storages, used for log driving, power and recreation, also have large modifying effects on all types of floods. Because of the control exerted by the lake storage, flood flows from this portion of the basin usually do not contribute greatly to downstream flood peaks,

TABLE B-1

RANGELEY LAKES - USABLE STORAGE

	D.A.		USABLE STORAGE		
	Net	Gross	Ac-Ft.	Inches Net	Inches Gross
KENNEBAGO	112	112	16,600	2.8	2.8
RANGELEY	90	90	30,700	6.4	6.4
MOOSELOOKMEGUNTIC	203	405	192,200	17.8	8.9
RICHARDSON LAKES	104	509	130,700	23.6	4.8
Sub-Total		509	370,200		13.7
AZISCOHOS	214	214	220,200	19.3	19.3
UMBAGOG	322	1045	70,700	4.1	1.3
Total		1045	661,100		11.9

The middle portion of the basin between Errol and Webb River drains about 1300 sq. mi. and is characterized by the Presidential and Mahoosuc Ranges of the White Mountains. Most of the tributaries are short with steep slopes and tend to generate the flood peak on the main stem of the river.

The lower portion of the basin which drains about 1105 square miles has relatively long tributaries with flat slopes and several small lakes and ponds. These physical features tend to modify and retard tributary floods. Because of their long travel time, these tributary peaks tend to synchronize with the main river peak that moves down from the central portion of the basin.

3. ANDROSCOGGIN RIVER

a. General. The main Androscoggin River originates at Errol Dam at the outlet of Umbagog Lake, New Hampshire, but the actual headwaters of the principal contributing streams lie about 50 miles further north. From Errol Dam, the river flows south turning sharply to the east near Gorham, New Hampshire. A short distance upstream from Livermore Falls, Maine the river turns sharply again to flow south to its outlet in Merrymeeting Bay, eight miles below the head of tidewater at Brunswick, Maine. Between Errol Dam and tidewater at Brunswick, the river descends a total of 1,245 feet in 161 miles, an average slope of about 7.7 feet per mile. Included in this total fall are two steep drops, one of about 240 feet in 2.5 miles at Berlin, New Hampshire, and a second of about 180 feet in 1.6 miles at Rumford, Maine.

A tabulation of pertinent data for the Androscoggin River and its tributaries is shown in Table B-2.

TABLE B-2

ANDROSCOGGIN RIVER AND TRIBUTARIES

River or Tributary	Drainage Area (square miles)
Magalloway River at Umbagog Lake	439
Rapid River at Umbagog Lake	520
Androscoggin River at Errol, N.H., USGS Gage	1045
Androscoggin River near Gorham, N.H., USGS Gage	1363
Peabody and Moose Rivers at mouth	71
Wild River at mouth	69
Sunday River at mouth	51
Bear River at mouth	43
Ellis River at mouth	163
Androscoggin River at Rumford, Me., USGS Gage	2067
Swift River at mouth	125
Webb River at mouth	132
Nezinscot River at mouth	181
Little Androscoggin River at mouth	353
Androscoggin River near Auburn, Me., USGS Gage	3257
Androscoggin River at head of tidewater	3450

b. Magalloway River. The Magalloway River flows through Aziscohos Lake and then follows a meandering course in a southerly direction for about 47 miles to its mouth at Umbagog Lake, about three miles above Errol Dam. It drains an area of 439 square miles and has a fall of approximately 500 feet. The principal tributary of the Magalloway River is the Dead Diamond River. From the confluence of its steep headwater sources this tributary flows in a general southeasterly direction for about 17 miles.

c. Rapid River. Rapid River commences at the outlet of the Richardson Lakes at Middle Dam and flows on a general northwesterly course for about seven miles to Umbagog Lake where it joins the Magalloway River to form the Androscoggin River. It drains an area of about 520 square miles which includes the Kennebago, Rangeley, Mooselookmeguntic and Richardson Lakes.

d. Moose River. The Moose River has its source in the town of Bowman, New Hampshire and flows in a general northeast direction to its confluence with the Androscoggin River in the town of Gorham, New Hampshire. It has a drainage area of about 24 square miles and extends from the peaks of the Presidential Range for about 12 miles to its mouth with a total fall of about 5,000 feet. The topography of the basin is mountainous with steep slopes and very little effective channel storage.

e. Peabody River. The Peabody River rises in the northwest portion of the town of Pinkham Notch, New Hampshire and flows in a general northwesterly direction to its confluence with the Androscoggin River in the southeast corner of the town of Gorham, New Hampshire. It drains an area of about 47 square miles and **extends** from the summit of Mt. Washington for about 12 miles to its mouth and has a total fall of about 5,500 feet. The topography of this basin is similar to that of Moose River basin.

f. Wild River. The Wild River has its source at North Ketchum Pond in Beans Purchase, New Hampshire. The river follows a generally northeasterly course entering the Androscoggin River in the northwest corner of Gilead, Maine. Its drainage area of 69 square miles extends from the summit of Mt. Washington for about 15 miles and has a total fall of about 5,500 feet. The topography at this basin also is similar to the Moose River basin.

g. Sunday River. The Sunday River has its source in the vicinity of Goose Eye Mountain in Riley, Maine and flows in a general southeasterly direction for about 14 miles to its confluence with the Androscoggin River in the town of North Bethel, Maine. It drains an area of approximately 51 square miles and has a fall of about 2,400 feet.

h. Bear River. The Bear River has its source just south of the town of Grafton Notch, Maine and flows in a southeasterly course for about 13 miles to enter the Androscoggin River at Newry, Maine. Its drainage area is about 43 square miles and its fall is about 860 feet.

i. Ellis River. The Ellis River rises in Ellis Pond in the town of Roxbury, Maine and flows generally south about 20 miles to its confluence with the Androscoggin River near Hanover, Maine. The topography of the basin above Andover is mountainous with steep slopes and very little effective channel storage. Below this point, there is a broad flat plain which extends about seven miles to below North Rumford. The Ellis River has a drainage area of 163 square miles and a fall of about 200 feet.

j. Swift River. The Swift River rises in Swift River Pond about six miles northeast of the town of Houghton, Maine and flows southerly about 25 miles to its confluence with the Androscoggin River at Mexico and Rumford. It drains an area of 125 square miles and has a fall of approximately 1800 feet.

k. Webb River. The Webb River rises in Lake Webb in the town of Weld, Maine at an elevation of 678 feet above mean sea level. The river follows a meandering course in a southerly direction for about 15 miles to its mouth at the Androscoggin River at Dixfield, Maine. Its drainage area is 132 square miles and its fall about 285 feet.

l. Nezinscot River. The East and West Branches of the Nezinscot River rise in the southern slopes of a hilly region in the southern part of Peru and the northwest corner of Woodstock, Maine. The two branches flow in a general southeasterly direction about 16 miles, uniting at a point one mile below the village center of Buckfield to form the Nezinscot River. Below Buckfield, the Nezinscot River follows an easterly course for 14 miles to its mouth at the Androscoggin River at Keens Mills, about 4.5 miles northeast of Turner, Maine. It has a drainage area of 181 square miles and a total fall of about 590 feet.

m. Little Androscoggin River. The Little Androscoggin River rises in Bryant Pond in Woodstock, Maine at an elevation of about 700 feet above mean sea level. The river flows south for a short distance and then east for the remainder of its 46 mile length where it joins the Androscoggin River at Auburn, Maine. It drains an area of 353 square miles and has a total fall of about 580 feet.

4. CLIMATOLOGY

a. General. The average climate of the Androscoggin River basin is characterized by relatively cool summers and long, cold, snowy winters especially at inland points. Prevailing westerlies and cyclonic disturbances that cross the continent from the west or southwest bring to the basin frequent but short periods of heavy precipitation. The basin is also exposed to occasional coastal storms, some of the tropical origin that travel up the Atlantic seaboard. These latter storms are heavily with moisture from the ocean but much of their original violence is lost before reaching Maine. Precipitation, temperature and snowfall data at Rumford, Lewiston, Berlin and Errol are tabulated in Tables B-3, B-4 and B-5 and shown graphically on Plate No. B-5.

b. Temperature. The average annual temperature of the Androscoggin River basin is about 43° F, ranging from 45° F at points near the coast to about 42° F in the headwaters. The yearly range of mean monthly temperature is wide, with temperatures between 64° F and 70° F in July and August, and between 15° and 20° F in January and February. Temperature extremes range from occasional highs slightly in excess of 100° F to infrequent lows below minus 30° F.

c. Precipitation. The average annual precipitation of the Androscoggin River basin is about 40 inches distributed rather uniformly throughout the year. At any one station the range between maximum and minimum values of average monthly rainfall is only about one to two inches. Much of the winter precipitation comes in the form of snow.

d. Snowfall. The annual snowfall over the watershed varies from about 80 inches near the coast to about 170 inches in the headwaters. The water content of the snow cover in the early spring often amounts to six to eight inches over the entire basin, with 10 inches or more being quite common in the higher elevations of the White Mountains.

TABLE B-3

MONTHLY TEMPERATURES
(Degrees, Fahrenheit)

Lewiston, Maine
Elevation 182 Ft. MSL
78 Years of Record

Month	Mean	Max.	Min.
January	19.1	64	-28
February	20.2	59	-28
March	30.3	82	-18
April	42.2	87	10
May	54.1	101	27
June	63.7	99	34
July	69.6	102	44
August	67.5	98	38
September	59.9	97	28
October	49.2	90	18
November	36.7	74	2
December	24.1	63	-27
Annual	44.7	102	-28

Rumford, Maine
Elevation 674 Ft. MSL
62 Years of Record

Month	Mean	Max.	Min.
January	17.6	64	-33
February	19.0	55	-34
March	29.2	79	-18
April	41.3	86	11
May	53.4	97	25
June	61.7	98	33
July	68.2	101	40
August	65.7	98	38
September	58.1	95	26
October	47.4	85	15
November	34.9	75	- 5
December	22.3	60	-27
Annual	43.2	101	-34

Berlin, New Hampshire
Elevation 1110 Ft. MSL
52 Years of Record

Month	Mean	Max.	Min.
January	14.9	67	-41
February	16.3	63	-39
March	27.1	80	-29
April	40.2	88	- 9
May	52.2	94	3
June	61.5	98	24
July	66.3	100	34
August	63.9	97	20
September	56.5	94	8
October	46.0	88	8
November	33.6	77	-13
December	19.8	66	-44
Annual	41.8	100	-44

Errol, New Hampshire
Elevation 1280 Ft. MSL
9 Years - 1932 thru 1941

Month	Mean	Max.	Min.
January	16.9	53	-30
February	18.6	49	-24
March	27.2	64	-20
April	40.1	78	5
May	51.9	88	26
June	61.7	92	32
July	66.4	92	44
August	64.0	90	36
September	56.0	87	24
October	44.9	78	18
November	34.3	68	- 6
December	21.6	60	-32
Annual	42.0	92	-32

TABLE B-4

MONTHLY PRECIPITATION RECORD
(in inches)

Lewiston, Maine
Elevation 182 Ft. MSL
88 Years of Record

Month	Mean	Max.	Min.
January	3.86	8.70	1.22
February	3.59	6.44	1.29
March	4.19	11.13	1.01
April	3.58	7.67	0.42
May	3.41	7.45	0.57
June	3.37	6.54	0.78
July	3.52	7.33	0.93
August	3.06	7.30	0.70
September	3.56	10.44	0.91
October	3.59	7.55	0.08
November	4.09	7.87	0.57
December	3.93	7.85	1.01
Annual	43.75	61.13	25.61

Rumford, Maine
Elevation 674 Ft. MSL
69 Years of Record

Month	Mean	Max.	Min.
January	2.91	4.79	0.98
February	2.69	4.87	0.85
March	3.34	13.06	0.91
April	3.26	6.72	0.48
May	3.39	8.43	0.69
June	3.45	7.35	1.31
July	3.71	6.20	0.98
August	3.27	6.44	0.97
September	3.56	9.06	0.33
October	3.34	8.41	0.04
November	3.68	8.25	0.61
December	3.08	6.37	0.83
Annual	39.69	62.36	34.44

Berlin, New Hampshire
Elevation 1110 Ft. MSL
62 Years of Record

Month	Mean	Max.	Min.
January	2.89	7.15	0.76
February	2.57	3.35	0.89
March	3.20	10.46	0.75
April	2.85	6.05	0.47
May	3.09	6.58	1.12
June	3.74	7.50	1.63
July	3.55	6.08	1.18
August	3.33	6.96	0.74
September	3.51	12.26	0.62
October	3.14	7.40	0.46
November	3.53	8.11	0.73
December	3.04	5.79	0.89
Annual	38.46	58.00	28.96

Errol, New Hampshire
Elevation 1280 Ft. MSL
74 Years of Record

Month	Mean	Max.	Min.
January	2.82	5.05	1.02
February	2.59	4.37	1.18
March	2.80	6.78	0.84
April	2.83	5.51	0.52
May	3.11	7.45	1.25
June	3.91	9.20	0.87
July	3.81	7.82	1.11
August	3.69	6.65	1.23
September	3.47	7.95	1.02
October	3.17	5.93	0.91
November	3.77	6.62	0.71
December	2.88	5.12	1.11
Annual	38.25	57.69	34.44

TABLE B-5

MEAN MONTHLY SNOWFALL
Depth in Inches

Lewiston, Maine
Elevation 182 Ft. MSL
74 Years of Record

Month	Snowfall
January	20.7
February	21.0
March	13.6
April	5.6
May	0.3
June	0.0
July	0.0
August	0.0
September	0.0
October	0.2
November	6.3
December	14.3
Annual	82.4

Rumford, Maine
Elevation 674 Ft. MSL
56 Years of Record

Month	Snowfall
January	22.0
February	21.2
March	16.2
April	6.2
May	0.3
June	0.0
July	0.0
August	0.0
September	0.0
October	0.5
November	7.6
December	18.8
Annual	90.8

Berlin, New Hampshire
Elevation 1110 Ft. MSL
61 Years of Record

Month	Snowfall
January	22.6
February	21.9
March	20.6
April	7.0
May	0.4
June	0.0
July	0.0
August	0.0
September	0.0
October	1.2
November	9.9
December	18.0
Annual	101.6

e. Storms.

(1) General. Three general types of storms occur in the Androscoggin River basin: Extratropical cyclones, tropical hurricanes, and rainstorms caused by the orographic influence of the mountain ranges on a relative moist air mass.

(2) March 1936 Storm. A succession of two storms within a period of 11 days caused heavy rains throughout the entire New England area. Rainfall for the period 10-20 March varied from a few inches along the coast to a maximum of about 20 inches in the White Mountains.

(3) March 1953 Storm. A main upper air low pressure system extending over the northeastern United States dominated the region's weather during the latter part of March. It drifted very slowly eastward and favored the development of four coastal storms and their intensification as they approached New England. Consequently, a practically steady flow of moist ocean air streamed over New England producing almost continuous precipitation during an eight day period extending from 24-31 March. Rainfall amounting to over nine inches was recorded at Pinkham Notch in the White Mountain Region.

(4) October 1959 Storm. A blocking high southeast of Newfoundland impeded the forward progress of a small storm off the Carolina coast and forced it to move slowly northwestward toward an intense disturbance over Michigan. The coastal storm intensified as it moved northwestward bringing strong southeast winds into the New England area. The strong winds picked up a considerable amount of moisture as they swept across the ocean and the moisture was deposited in the form of rain especially over the mountainous areas. In this storm of 23-26 October over 10 inches of rain was recorded at Pinkham Notch in the White Mountains.

5. STREAMFLOW

The U.S. Geological Survey has maintained and published records of fourteen stream gaging stations in the Androscoggin River basin. Nine stations are presently in operation, all of which are water-stage recorders as shown on Table B-6. Records of flow at Rumford are determined from gage readings furnished by the Rumford Falls Power Company.

TABLE B-6

STREAMFLOW RECORDS - ANDROSCOGGIN RIVER BASIN

Location of Gaging Station	Drainage Area (sq. mi.)	Period of Record	Discharge (cfs) Mean	Maximum	Minimum
Diamond River nr. Wentworth Location, N.H.	153	1941-	342	8,630 6/16/43	6.8
Androscoggin River at Errol, N.H.	1,045	1905-	1,885	15,700 * 6/18/43	Leakage
Androscoggin River at Berlin, N.H.	1,350	1913-1928	2,313	20,000 6/18/17	960 *
Androscoggin River at Gorham, N.H.	1,363	1928-	2,444	20,000 * 4/30/23	456
Androscoggin River at Rumford, Maine	2,067	1892	3,681	74,000 3/20/36	625 *
Swift River nr. Roxbury, Maine	95.8	1929-	196	16,800 10/24/59	3.8
Nezinscot River at Turner Center, Maine	171	1941-	298	13,900 3/27/53	5.6
Little Androscoggin River nr. South Paris, Maine	76.2	1913-1924; 1931-	137	8,000 3/27/53	1
Little Androscoggin River nr. Auburn, Maine	328	1940-	549	16,500 3/28/53	14 *
Androscoggin River nr. Auburn, Maine	3,257	1928-	5,989	135,000 3/20/36	340 *

* Daily Discharge

6. LOW FLOW

Regulation of the storage in the Rangeley Lakes for power generation at downstream stations along the Androscoggin River insures a flow of about one cubic foot per second per square mile (csm) about 90 percent of the time. Releases from the Rangeley Lakes with the exception of Kennebago Lake, are controlled by the Union Water Power Company, a subsidiary of the Central Maine Power Company. In accordance with an agreement between the company and several of the downstream water users, a minimum flow of 1550 cfs is maintained at the USGS gage at Gorham insofar as possible. Flows below the desired minimum have occurred occasionally, notably during low flow periods of 1930-31, 1941-42 and 1947-48. The minimum observed daily flow at Gorham was 795 cfs on 15 March 1948.

7. FLOODS OF RECORD

a. Historic Floods. The history of floods in the Androscoggin River basin goes back nearly 179 years with records indicating the occurrences of floods in 1785, 1814, 1820, 1826, 1827, 1846 and 1869. The longest period of flow records has been maintained by the Rumford Falls Power Company at Upper Falls, Rumford, Maine where systematic records were started in 1892.

b. Recent Floods. The March 1936 flood was the greatest flood of record in the lower reaches of the Androscoggin River. This flood was caused by unseasonably warm temperatures and heavy rain on top of the snow cover. Flooding at several locations was further aggrevated by severe ice jams. Two distinct storms occurred in March. During the first storm, occurring from 9 to 14 March, 5.8 inches of rainfall was recorded in Rumford, Maine and 8.8 inches at Pinkham Notch, New Hampshire. During the second storm, occurring from 16 to 23 March, 5.8 inches was recorded at Rumford and 13.7 inches at Pinkham Notch. The second storm produced the highest recorded peak flow at 74,000 c.f.s. at Rumford and the largest flood losses ever experienced in the basin.

The March 1953 flood is the second largest general basin flood that has occurred in recent years. Precipitation occurred during most of the month culminating with an average of about five inches between 24-27 March. A major flood and severe damages were experienced along the entire length of the main river from Berlin to Brunswick and along several tributary streams. The recorded peak flow at Rumford was 56,700 c.f.s.

The October 1959 flood produced record peak discharges on the tributaries that drain between Berlin and Rumford. At the USGS gage on the Swift River near Roxbury, Maine (D.A. = 95.8 sq. mi.) the recorded record peak flow was 16,800 c.f.s. or 176 c.s.m. The limited areal extent of the storm prevented development of a major flood on the main stem of the river.

Nine floods of sufficient magnitude to cause significant damage have occurred in the basin. The dates and magnitude of these floods at Rumford are shown in Table B-7.

TABLE B-7

MAJOR FLOODS

ANDROSCOGGIN RIVER BASIN

Flood	Maximum Daily Discharge (cfs)	Peak Discharge (cfs)
20 March 1936	68,300	74,000
15 April 1895	55,230	(not known)
28 March 1953	52,700	56,700
25 October 1959	41,700	46,800
5 November 1927	39,100	46,700
2 March 1896	39,010	(not known)
25 November 1963	31,500	35,400
27 November 1950	31,100	33,400
15 June 1942	26,600	30,200

c. Flood Profiles. High water profiles determined for the Androscoggin River from field surveys following the flood of March 1936 are shown on Plate Nos. B-2, B-3, and B-4.

d. Flood Frequencies. Peak discharge-frequency curves were computed for all gaging stations in the basin. The frequency analyses were made in accordance with the procedures outlined in EM 1110-2-1450. The method assumes that the logarithmic values of annual peak flows are normally distributed, thereby permitting the application of standard statistical analysis. This enables the discharge-frequency curve to be defined by its mean value and standard deviation. Based on a regional analysis, a skew coefficient of 1.0 was adopted for the Androscoggin River basin. The basic frequency data for gaging stations was used to derive frequency curves applicable to the damage zones for economic studies. A tabulation of the natural frequency curve data for the damage zones is shown in Table B-8. Frequency curves at various gaging stations along the main stem are shown on Table B-6.

8. ANALYSIS OF FLOODS

a. General. The major floods of record were analyzed to determine the hydrologic development of the floods and the tributary components contributing to the crests on the main river. Such a study is essential to appraise the flood potentialities of the basin and to determine tributaries which should be controlled to obtain the most effective flood reductions.

b. Flood Routing. Because of its simplicity in derving routing coefficients and its adaptability for component routing, the progressive average-lag method of flood routing was adopted for all reaches except between Rumford and Auburn. A variable coefficient routing method was used between these two zones. The Androscoggin River basin was divided into tributary watershed and subareas for flood analysis as shown on Plate No. B-1. The routing coefficients were obtained by trial from the floods of record and were selected on the basis of the best reproduction of the recorded hydrographs.

c. Analysis of Floods. The results of the flood analyses are shown graphically on Plate Nos. B-20 and B-21 for the 1936 and 1953 floods. The discharge contribution of the tributary areas to the peak discharge at selected index stations are tabulated in Table B-9 and are described as follows:

TABLE B-8

ANDROSCOGGIN RIVER

TABULATION OF NATURAL FREQUENCY CURVE DATA
FOR
DAMAGE ZONES

		ZONES										
Exceedence Freq. per 100 years	Exceedence Interval in years	1,2& 3 Auburn (USGS Gage) RM 28.4	4 & 5 Rt. 202 Hwy Bridge RM 30.6	6,7 & 8 Livermore Falls Dam RM 61.8	9 & 10 Ridlonville Hwy Bridge RM 85.6	11 Rumford Upper Falls RM 88	12 Bethel RM 105	13 West Bethel RM 113	14a-1 Shelburne Falls Dam RM 127.6	14a-2 N.H.P.S. Co. Dam RM 130.3	14b,15 & 16 Gorham (USGS Gage) RM 134.4	17 Errol Dam RM 168.6
.05	2,000	250,000	220,000	180,000	165,000	145,000	120,000	102,000	64,000	43,500	28,000	19,000
.10	1,000	218,000	190,000	155,000	140,000	125,000	105,000	91,500	59,000	40,500	26,800	18,400
.25	400	177,000	155,000	128,000	115,000	104,000	87,000	80,000	53,000	36,900	25,000	17,500
.50	200	152,000	130,000	108,000	96,000	87,000	76,000	68,000	46,800	34,000	23,500	16,700
1.00	100	122,000	108,000	90,000	81,000	74,000	65,000	59,000	42,000	31,000	22,100	15,900
1.25	80	114,000	100,000	85,000	76,000	70,000	62,500	57,000	40,400	30,200	21,900	15,500
1.50	66.7	108,000	95,000	81,000	73,000	67,000	60,000	55,000	39,200	29,700	21,400	15,300
2.0	50	100,000	87,000	76,000	67,500	63,000	56,000	52,000	37,200	28,400	20,700	14,900
3.0	33.3	87,000	77,000	68,000	61,000	57,000	51,000	47,000	34,800	26,800	19,800	14,200
4.0	25	80,000	71,000	63,000	57,000	53,000	48,000	44,000	33,000	25,500	19,000	13,800
5.0	20	74,100	67,000	60,000	54,000	50,000	45,500	42,000	31,600	24,800	18,500	13,500
10.0	10	62,400	55,000	50,000	46,000	42,000	38,500	35,200	27,200	21,800	16,900	12,100
20.0	5	51,600	46,000	41,000	38,000	35,700	32,000	29,200	23,100	18,700	15,100	10,500
30.0	3.3	46,100	41,000	36,700	34,000	32,000	28,000	26,000	20,800	16,900	14,100	9,400
40.0	2.5	42,500	38,000	34,000	31,500	29,800	25,500	23,600	19,000	15,700	13,400	8,500
50.0	2	39,700	36,000	31,600	29,300	27,800	23,200	21,900	17,600	15,000	12,800	8,000
60.0	1.7	37,700	34,000	30,000	28,000	26,400	22,200	20,500	16,800	14,100	12,200	7,500
70.0	1.4	36,000	33,500	28,600	27,000	25,200	21,300	19,600	15,900	13,600	11,700	7,200
80.0	1.25	34,500	31,200	27,500	26,000	24,200	20,900	19,000	15,200	13,000	11,000	6,900
90.0	1.11	33,200	30,000	26,500	25,000	23,200	20,000	18,300	14,500	12,500	10,500	6,600
95.0	1.05	32,800	29,600	26,000	24,500	22,900	19,800	18,000	14,100	12,100	10,300	6,500
99.0	1.01	32,300	29,000	25,500	24,000	22,600	19,100	17,300	13,600	11,800	10,200	6,200
99.99	1+	32,200	28,800	25,000	23,900	22,500	19,000	16,900	13,000	11,500	10,100	6,000

TABLE B-9

TRIBUTARY CONTRIBUTIONS
TO
MAIN RIVER FLOOD PEAKS

ANDROSCOGGIN RIVER BASIN, ME. & N.H.

Location	Contributing Component	Drainage Area (sq.mi.)	Drainage Area (%)	Discharge March 1936 (c.f.s.)	March 1936 (%)	Discharge March 1953 (c.f.s.)	March 1953 (%)	Discharge TTCF (c.f.s.)	TTCF (%)
Gorham, N.H.	Androscoggin at Errol	1,045	76.7	5,500	28.8	2,300	13.0	2,000	10.0
	Local - Errol to Gorham	318	23.3	13,600	71.2	15,400	87.0	18,000	90.0
		1,363	100.0	19,100	100.0	17,700	100.0	20,000	100.0
Rumford, Me.	Androscoggin at Errol	1,045	50.5	4,100	5.5	1,000	1.8	2,800	4.5
	Local - Errol to Gorham	318	15.4	10,200	13.8	6,900	12.6	8,200	13.1
	Moose & Peabody Rivers (1)	95	4.6	12,900	17.4	4,500	8.2	8,700	14.0
	Local Area	65	3.1	5,000	6.8	3,400	6.2	3,200	5.1
	Wild River	69	3.3	10,100	13.6	3,700	6.7	6,600	10.6
	Local Area	99	4.8	9,000	12.2	8,400	15.3	8,200	13.1
	Sunday River	51	2.5	4,300	5.8	4,400	8.0	3,900	6.2
	Local Area	22	1.1	1,600	2.2	1,900	3.4	1,500	2.4
	Bear River	43	2.1	3,000	4.0	3,700	6.7	2,800	4.5
	Local Area	32	1.6	2,300	3.1	2,700	4.9	2,700	4.3
	Ellis River	163	7.9	9,300	12.6	9,000	16.4	10,700	17.2
	Local Area	65	3.1	2,200	3.0	5,400	9.8	3,100	5.0
		2,067	100.0	74,000	100.0	55,000	100.0	62,400	100.0
Auburn, Me.	Androscoggin at Errol	1,045	32.2	3,700	3.1	6,500	6.5	2,800	2.9
	Local - Errol to Gorham	318	9.7	9,100	7.7	1,000	1.0	6,600	6.8
	Moose & Peabody Rivers (1)	95	2.9	9,800	8.3	4,100	4.1	6,500	6.7
	Local Area	65	2.0	3,900	3.3	3,000	3.0	2,400	2.5
	Wild River	69	2.1	7,900	6.7	3,200	3.2	4,800	5.0
	Local Area	99	3.0	7,500	6.4	6,800	6.8	6,400	6.6
	Sunday River	51	1.6	3,600	3.0	3,600	3.6	3,000	3.1
	Local Area	22	0.7	1,300	1.1	1,500	1.5	1,200	1.2
	Bear River	43	1.3	2,600	2.2	3,000	3.0	2,100	2.2
	Local Area	32	1.0	2,200	1.9	1,600	1.6	2,400	2.5
	Ellis River	163	5.0	8,800	7.5	8,500	8.5	9,400	9.7
	Local Area	65	2.0	2,800	2.4	4,400	4.4	3,600	3.7
	Sub-total Androscoggin above Rumford	2,067	63.5	63,200	53.6	47,200	47.2	51,200	52.9
	Swift River	125	3.8	11,400	9.7	7,500	7.5	8,500	8.8
	Webb River (2)	145	4.5	4,800	4.0	3,700	3.7	4,100	4.2
	Local Area	159	4.9	7,100	6.0	4,400	4.4	6,700	6.9
	Local Area	164	5.0	3,300	2.8	4,500	4.5	6,200	6.4
	Nezinscot River	181	5.6	8,300	7.0	13,500	13.5	6,200	6.4
	Local Area	63	1.9	3,500	3.0	2,700	2.7	2,000	2.0
	Little Androscoggin River	353	10.8	16,400	13.9	16,500	16.6	12,000	12.4
		3,257	100.0	118,000(3)	100.0	99,900	100.0	96,900	100.0

(1) Includes 24 sq. mi. of local area.
(2) " 13 " " " " "
(3) Adjusted for effect of ice jam.

(1) Above Errol Dam. The flood runoff from the area above Errol Dam is greatly modified by the large amount of storage in lakes which are usually filled during the spring runoff season of March, April and May. The total usable capacity of the lake storage is about 661,000 acre-feet, which is equivalent to almost 12 inches of runoff from the entire 1045 square miles. In most years the lake storage is filled with very little spillage. Only during major floods, similar to March 1936, is there an appreciable amount of flood flow from the lake area. The drainage area of 1045 square miles above Errol Dam represents nearly 50 percent of the watershed above Rumford but contributes less than five percent to the peak flow. At Auburn, the 1045 square miles above Errol represents about one-third of the total drainage area but contributes less than three percent to the peak flow.

(2) Errol to Gorham. This area comprises 318 square miles and represents about 23 percent of the drainage area at Gorham. The peak at Gorham is usually generated by the flood flow from this area with the outflow from the Rangeley Lakes area arriving a few days later. At Gorham, the flood hydrograph is double peaked. The first, usually the higher, represents the runoff from the 318 square miles while the second peak, usually the lower, represents the runoff from the Rangeley Lakes area. Runoff from the 318 square miles contributes about 13 percent to the flood peak at Rumford and about seven percent to the flood peak at Auburn.

(3) Gorham to Rumford, Maine. The principal flood-producing tributaries drain the slopes of the White Mountains and are located in the central portion of the basin. Major flood contributors are the Moose, Peabody, Wild and Swift Rivers which drain a total of about 265 square miles. At Auburn this represents eight percent of the gross drainage and 12 percent of the net drainage area (excluding the area above Errol). These four streams, however, contribute on the average about 20 percent to the peak flow. The Sunday and Bear Rivers also are large flood contributors.

Because of the large amount of natural storage on the lower portion of the Ellis River, its contributions to flood flows is uncertain. Three gaging stations have been placed in operation to help analyze the concurrent flows on the Ellis and Androscoggin Rivers during flood periods. (See paragraph 11a for further discussion on this subject.)

(4) Rumford, Maine to Mouth. The Nezinscot and Little Androscoggin Rivers are the large flood contributors from the lower portion of the basin. These two tributaries drain about 24 percent of the net drainage area at Auburn and contribute about that same amount to the peak flow.

9. TYPICAL TRIBUTARY CONTRIBUTION FLOOD

a. General. To evaluate the relative flood control effectiveness of various plans, a synthetic flood was developed to represent typical contributions from all principal tributaries in the Androscoggin River basin. It is called the "Typical Tributary Contribution Flood" (TTCF). The TTCF was developed in accordance with the method set forth in the NENYIAC Report, Part Three, Volume 3, Section XIX.

b. Storm. The storm producing the TTCF was assumed to be distributed throughout the basin in an isohyetal pattern approximating that of the average annual precipitation. A study of the storms producing the four floods analyzed in the Androscoggin River basin (March 1936, June 1942, November 1950 and March 1953 floods) showed some variations from the average annual rainfall pattern. Allowance for these variations was made in deriving the tributary components of the TTCF. The volume of runoff for each tributary hydrograph was assumed to be about 10 percent of the average annual rainfall.

c. Discharge. In the development of the TTCF, it was assumed that the areas under the tributary discharge-frequency curves best indicate the relative flood-producing potential of each tributary. The peak flows of the TTCF on the tributaries therefore were related to the areas under the discharge-frequency curves when plotted on arithmetic probability paper. The probability limits for area measurement were assumed to be between 50 percent chance of occurrence (2 years) and 0.05 percent (2,000 years). Selection of these limits were based on the fact that the 50 percent probability flood represents the approximate beginning of damages while the 0.05 percent probability is the upper limit considered in economic analysis. The area under frequency curves for each tributary was related to that of an index station and expressed in terms of percentage. The Androscoggin River at Auburn was selected as the index station with an approximate peak discharge of 100,000 cfs.

d. Timing of TTCF. To determine the timing of the TTCF, a study was made of the relative timing of the tributary peaks from analysis of the past floods of record. An average timing was then selected for each tributary peak.

The typical tributary contribution flood hydrographs at selected locations are shown on Plate No. B-22. The discharge contributions of the tributary areas to the peak discharge at the index stations are tabulated in Table B-9 and shown graphically on Plate No. B-22.

10. RECOMMENDED PLAN

a. General. The recommended plan, as discussed in the main report, consists of Pontook Dam and Reservoir. This project, located on the Androscoggin River about 12 miles upstream of Berlin, New Hampshire, would be developed for flood control, power, and recreation. For purposes of this study, it has been assumed that storage in Pontook would be operated in conjunction with the storage available in the existing reservoirs in the Rangeley Lakes system. Arrangements with the owners will be formulated during design stage of the Pontook project.

b. Storage. Pontook Reservoir will have a gross storage capacity of 238,000 acre-feet. Allocation of this storage is as follows:

	Elev. ft.	Storage ac.-ft.
Dead	1182	39,000
Power and Flood Control	1212	141,000
Flood Control Exclusively	1220	58,000
Total		238,000

(1) Flood Control Storage. As noted above, Pontook Dam will be operated for multiple-purpose use in conjunction with the available storage in the Rangeley Lakes. At Pontook, 58,000 acre-feet of storage will be reserved exclusively for flood control. This is equivalent to about one inch of storage on the gross drainage area of 1,215 square miles and about six inches of storage on the net drainage area of 170 square miles downstream of Errol Dam. By operating the overall storage according to computed rule curves, it would be possible to draw down the combined storage of the Rangeley Lakes and Pontook to provide about 560,000 acre-feet for spring runoff, equivalent to over eight inches of runoff from the 1,215 square miles of drainage area.

(2) Power Storage. From mass curve and low flow analyses, it was determined that 141,000 acre-feet of storage at Pontook, together

with the 661,000 acre-feet in the Rangeley Lakes, would provide a minimum dependable flow of 1,675 cfs at Pontook. Mass curves were developed from USGS gage records of observed and natural flows at Errol Dam (drainage area = 1,045 square miles) and at Gorham (drainage area = 1,363 miles). Stream flow records have been maintained by the USGS at Errol since 1905 and at Gorham since 1913. A detailed analysis of power storage is given in Appendix F.

(3) Dead Storage. A permanent pool at elevation 1182, with 39,000 acre-feet of storage, will provide a minimum net operating power head of 62 feet. Maximum net operating head at elevation 1212 will be 92 feet.

c. Spillway Design Flood. In deriving the spillway design flood for Pontook Reservoir, the drainage area was divided into three areas: (1) the area upstream of Aziscohos and Richardson Lakes (DA =723 square miles); (2) the area between Aziscohos and Richardson Lakes and Errol Dam(DA = 322 square miles); and (3) the area between Errol Dam and Pontook Dam. The adopted spillway design flood for Pontook Reservoir is illustrated on Plate No. B-19. Because of the large amount of storage upstream of Aziscohos and Richardson Lakes, it was assumed that the spillway design flood from this area would be greatly reduced and would not synchronize with the spillway design flood at Pontook. Aziscohos Lake on Magalloway River controls 214 square miles and has a usable capacity of about 20 inches of runoff. A foot rise in the pool is equivalent to about two inches of runoff. The system of lakes on Rapid River controls 509 square miles of drainage area and has a usable capacity of 370,200 acre-feet of storage which is equivalent to almost 14 inches of runoff. A foot rise on the lake levels is equivalent to about 1.5 inches of runoff.

A spillway design flood was computed for the area between Aziscohos and Richardson Lakes and Errol Dam (DA = 322 square miles). This flood was routed through the surcharge storage at Umbagog Lake and added to the spillway design flood computed for the 170 square miles that drains the area between Errol Dam and Pontook Dam.

(1) Unit Hydrographs. Three-hour unit hydrographs were derived for the 322 square miles of drainage area between Aziscohos and Richardson Lakes and Errol Dam, and for the 170 square miles of drainage area between Errol and Pontook Dams. The 170 square miles were separated into Clear Stream (DA = 65 square miles) and the reservoir peripheral area of 105 square miles. The unit hydrographs were based on a unit hydrograph study of the Swift River near Roxbury, Maine (DA = 95.8 square miles). Hydrograph data for the Diamond River near Wentworth Location, New Hampshire (DA = 153 square miles) was investigated but was found to be unsuitable for unit hydrograph analysis. For the Swift River, unit hydrographs were derived for the following floods: June 1942, June, 1943, November 1950, September 1954 and October 1959.

The results of these studies are shown on Plate Nos. B-7 through B-17. Based on these studies, the peaks of the adopted 3-hour unit hydrographs for deriving a spillway design flood were selected at about 84 csm or 15 percent greater than the highest derived unit hydrograph peak. The time of concentration varied from 3 hours to 5 hours. The adopted three-hour unit hydrographs for Pontook Reservoir are shown on Plate No. B-18. A comparison of the adopted values for Pontook Reservoir and other reservoir sites in New England is given in Table B-10.

(2) Probable maximum precipitation. The probable maximum precipitation was taken from Hydrometeorological Report No. 33. It was assumed that the storm was centered over the 170 square miles between Errol and Pontook Dams, while the 322 square miles above Errol Dam received the residual rainfall. Infiltration and other losses were assumed at a rate of 0.20 inch per three hours. Data for the probable maximum precipitation, losses and excesses are tabulated in Table B-11.

(3) Spillway design inflow. The spillway design flood inflow to Pontook of 190,000 cfs was computed by applying rainfall excesses to adopted unit hydrographs. Of this total, 167,000 cfs is contributed by the area downstream of Errol Dam, and 23,000 cfs is contributed by the area upstream of Errol Dam.

TABLE B-10

UNIT HYDROGRAPH RELATIONSHIPS

Location	Drainage Area	3-Hr. Unit Hydrograph Design Flood		W-50	W-75	640 Cpr	tpr
	sq. mi.	cfs	csm	hrs.	hrs.		
Clear Stream	65	5,500	84	6.0	3.5	378	4.5
Pontook (Peripheral)	105	8,800	84	6.0	4.0	252	3.0
Errol (Net)	322	27,000	84	6.0	3.5	420	5.0
Swift River	95.8	7,000	73	6.5	4.0	547	7.5
Otter Brook	47	2,080	44	8.5	5.5	352	8.0
North Hartland	220	17,160	78	4.0	3.0	390	5.0
North Springfield	123	10,750	87	5.0	2.5	565	6.5

TABLE B-11

PROBABLE MAXIMUM PRECIPITATION

TIME hrs.	Pontook Reservoir Net Area 170 Sq. Mi. Rainfall in.	Losses in.	Rainfall Excess (in.)	Rainfall Pattern (in.)	Umbagog Lake * Net Area 322 Sq. Mi. Rainfall in.	Losses in.	Rainfall Excess (in.)	Rainfall Pattern (in.)
0	0	0	0	0	0	0	0	0
3	10.5	0.2	10.3	0.1	7.4	0.2	7.2	0.3
6	2.6	0.2	2.4	0.4	1.8	0.2	1.6	0.43
9	1.5	0.2	1.3	1.3	1.5	0.2	1.3	1.3
12	1.0	0.2	0.8	10.3	1.07	0.2	0.87	7.2
15	0.6	0.2	0.4	2.4	0.63	0.2	0.43	1.6
18	6.6	0.2	0.4	0.8	0.50	0.2	0.3	0.87
21	0.4	0.2	0.2	0.4	0.50	0.2	0.3	0.3
24	0.3	0.2	0.1	0.2	0.36	0.2	0.16	0.16
27	0.3	0.2	0.1	0.1	0.20	0.2	0	0
30	0.2	0.2	0	0	0.20	0.2	0	0
Total	18.0	2.0	16.0	16.0	14.16	2.0	12.16	12.16

* Area between Richardson and Aziscohos Lakes and Errol Dam

d. Spillway design flood discharge. The spillway design flood outflow was computed by routing the inflow through the surcharge storage assuming various spillway lengths. It was assumed that the pool was at spillway crest and the outlets operative at the beginning of the flood. With the outlets or turbines discharging 15,000 c.f.s., the spillway discharge, for the selected 485-foot side channel spillway, was 68,000 c.f.s., with an 11-foot surcharge. Consideration was given to the effect of a failure at the upstream Errol Dam. From a study of cross sections of the river it was estimated that the channel downstream of Errol Dam would limit the discharge to about 50,000 cfs. In order to take into account the failure or redevelopment of Errol Dam, the surcharge was increased three feet to 14 feet with a corresponding spillway design discharge of 93,000 cfs for the selected 485-foot spillway length.

e. Freeboard. The freeboard was computed using the method outlined in Technical Memorandum No. 132 entitled: "Waves in Inland Reservoirs", November 1962. For an assumed maximum wind of 80 miles per hour the computed freeboard was four feet. A minimum of five feet was adopted.

f. Outlet. The flood control outlets for Pontook Reservoir, as shown on Plate 5 of the main report, will be located at the lower end of the spillway and will consist of five 10' x 10' sluices, each controlled by a slide gate. The outlets with a discharge capacity of about 15,000 cfs were designed to satisfy the following criteria: (1) with one gate inoperative, obtain outlet discharge equivalent to the downstream safe channel capacity of 12,000 cfs without utilizing more than a minor portion of the flood control storage capacity; (2) permit emptying the flood control storage portion of the reservoir in a reasonable period of time; (3) pass flood flows from Errol Dam in excess of power requirements; and (4) provide adequate diversion capacity during construction. Although the power turbines will have the capacity to discharge about 23,000 cfs, the outlet has been included in the design at this time to insure adequate capacity. Studies during the design stage may indicate that the number of outlets may be reduced or even eliminated.

g. Reregulating Pool. Inasmuch as power will be developed at Pontook at a low load factor, a dam will be constructed 3.5 miles downstream of Pontook dam to reregulate the discharge to usable flow for downstream plants. The pool, extending upstream to the main dam, will have a capacity of 9,300 acre-feet at the spillway crest elevation of 1118. A fixed spillway, 155 feet long, and a 20-foot surcharge were selected to provide a discharge capacity of 50,000 cfs. This capacity is about one-half of that provided at the main dam but is considered adequate for this type of structure. The outlets will consist of four gates; a 15' x 9' gate for a log sluiceway and passage of flood flows, a 22' x 15' gate for the penstock to the hydro units, and two 9' x 4' gates for reregulating when the power station is not operating.

In order to reregulate the peaking flow from the main dam to 1,675 cfs, it will require 4,100 acre feet of storage. Generating capacity of 3,000 KW will be provided.

h. Reservoir regulation. Pontook Dam will be regulated to reduce flood flows along the Androscoggin River during flood periods, and, together with the reregulating dam, will provide power and assure dependable runoff from the watershed even during extreme dry periods.

(1) Flood Regulation. Pontook Reservoir flood control storage will be regulated with the reservoirs in the Rangeley Lakes system to control the flood runoff from the 1,215 square miles of drainage area at Pontook Dam. Stage and discharge reductions will be afforded by this regulation at the major damage centers along the Androscoggin River such as Berlin and Gorham, New Hampshire and Rumford, Mexico, Lewiston and Auburn, Maine. A tentative method of regulation was prescribed and tested on the record March 1936 flood which produced an unusually high volume of runoff from the entire watershed. Regulation of the flood and the effect at downstream damage centers are shown on Plate No. B-23. Discharge reductions at selected locations are given in Table B-12.

TABLE B-12

MARCH 1936 FLOOD
EFFECT OF PONTOOK RESERVOIR REGULATION
AND REREGULATION OF UPSTREAM STORAGE RESERVOIRS

Location	Observed (c.f.s.)	Modified (c.f.s.)	Reduction (c.f.s.)	Reduction (%)
Pontook Dam	16,000	8,000 (1)	8,000	50.0
Berlin, N.H.	19,900	12,000 (2)	7,900	39.6
Rumford, Maine	74,000	66,500	7,500	10.1
Auburn, Maine	118,000	113,000	5,000	4.2

(1) During development of flood, outflow curtailed to power requirements of 1,675 c.f.s.

(2) During development of flood, with flow from Pontook curtailed to 1,675 c.f.s., flow at Berlin would be 9,000 c.f.s. Flow would be increased to 12,000 c.f.s. (safe channel capacity) after flood crest has passed downstream damage centers.

For this regulation study, it was assumed that all storage reservoirs were on their respective rule curves at the beginning of the flood. (Development of system rule curves is discussed in Appendix F.) By restricting the outflow to an average poower release rate of 1,1675 c.f.s. during the initial development of the flood it was possible to attain substantial flood reductions at downstream damage centers. When the flood peak at Rumford began to recede, the outflow was increased to 8,000 c.f.s. which was maintained until the end of April when the entire system would have receded to the system rule curve. Under the method of operation, Pontook reservoir would rise to elevation 1221 or one foot above spillway crest.

It is expected that there will be close coordination in the future between the Union Water Power Company and the Corps of Engineers in the regulation of the Rangeley Lakes System and Pontook Reservoir during flood periods. By use of flood volume predictions based on snow surveys and precipitation forecasts, it may be possible to further reduce the outflow from Pontook during a 1936 type flood with more effective use of storage in the upstream lakes.

(2) Low flow regulation. Average monthly flow records at the Gorham gage show that, of the 261 months studied between 1938 and 1959, 22 months showed flows less than the minimum 1,550 cfs which is desired by the water users on the river at Gorham, the lowest being 1,257 cfs. The reregulating dam at Pontook would provide a minimum dependable release of 1,675 c.f.s.

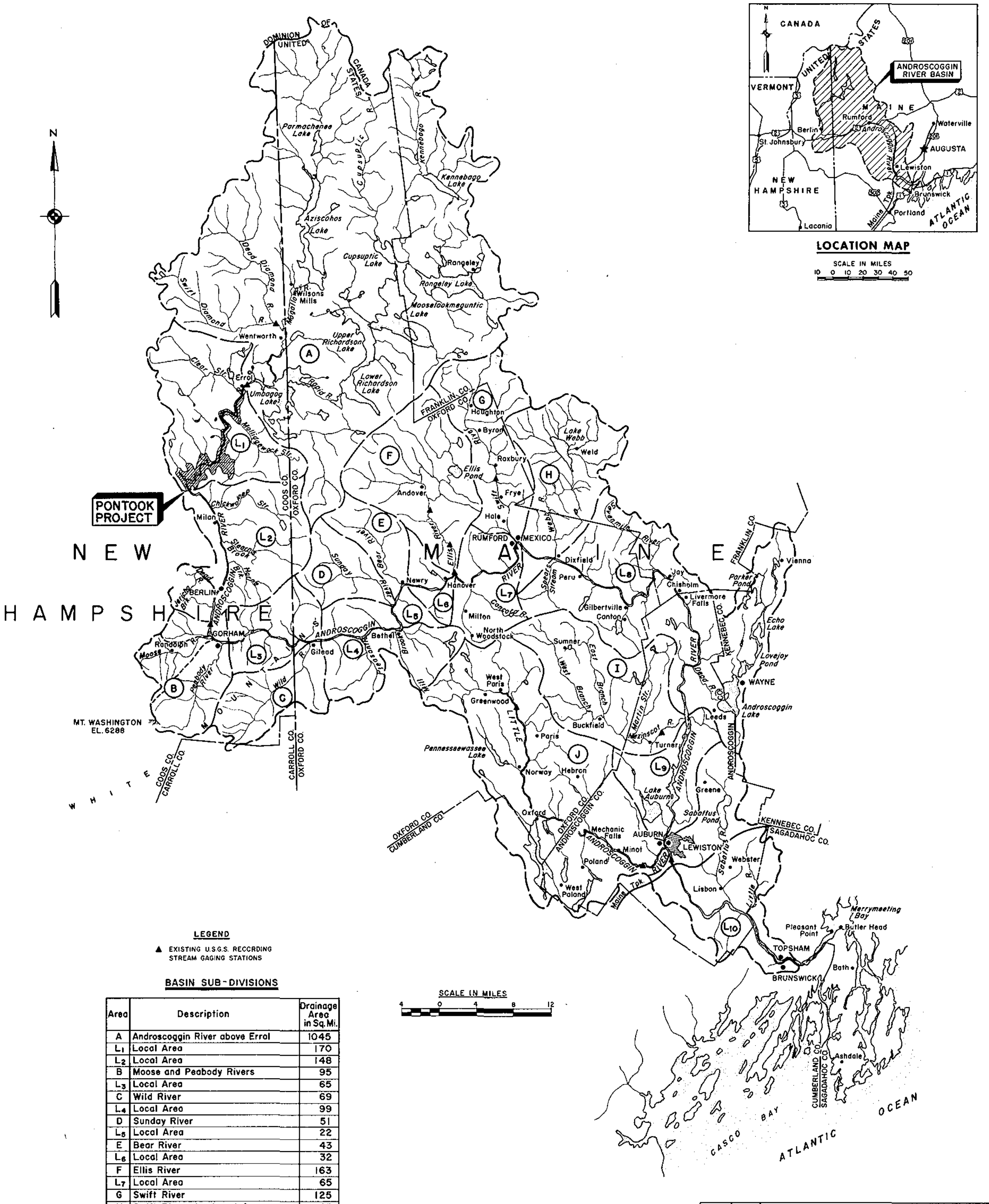
11. OTHER PROJECTS STUDIED

a. Ellis Dam and Reservoir. The Ellis dam site is located in the town of Rumford, Maine on the Ellis River approximately one mile above its confluence with the Androscoggin River. The project was studied for flood control alone and for flood control in combination with recreation and hydroelectric power. The reservoir impounded by the dam would have a flood control storage of 70,000 acre-feet equivalent to eight inches of runoff from a drainage area of 164 square miles.

The unit hydrograph analysis developed for the Swift River was assumed to be applicable to the ungaged Ellis River. From observations of local residents, and further analysis of the extensive natural storage characteristics of the lower Ellis River, it is now considered the flood records for the Swift River gage are not applicable for the Ellis River at its mouth. Field observations indicate that rapid rises on the Androscoggin River cause water to flow upstream at the mouth of the Ellis River into the storage area. This unusual characteristic tends to both reduce the flow on the Androscoggin River and temporarily delay all discharge from the Ellis River. This reduction effect occurs principally while the stages are rising on the main river, diminishes as the main river crests, and adds to the flow while the flood stages are receding.

At this time there is insuffficent information available to adequately analyze this phenomenon. Various assumptions have been made in studying the effect of the valley storage, but there are too many variables and unknowns to have confidence in the results. To obtain basic data, the U.S. Geological Survey has recently installed three temporary gaging stations on the lower Ellis River. Since the installation of these gages, two minor rises have occurred, both of which lacked sufficient hydraulic data for a thorough evaluation. It is proposed to maintain the gages in the interest of obtaining additional information.

b. Hale and Roxbury Projects. Two flood control reservoir sites were studied on the Swift River because of its high contribution to flood flows. However, because of the high construction costs of the dams, neither the Hale site, draining 111 square miles, nor the Roxbury site, draining 80 square miles, was economically feasible. Both sites were investigated for flood control alone; the Hale site was also investigated for flood control in combination with power and recreation. Flood control storage requirements were equivalent to approximately eight inches of runoff. Unit hydrographs for determining spillway design floods were based on unit hydrograph studies for the Swift River at the USGS gage at Roxbury, drainage area 95.8 square miles.



LEGEND

▲ EXISTING U.S.G.S. RECORDING STREAM GAGING STATIONS

BASIN SUB-DIVISIONS

Area	Description	Drainage Area in Sq. Mi.
A	Androscoggin River above Errol	1045
L_1	Local Area	170
L_2	Local Area	148
B	Moose and Peabody Rivers	95
L_3	Local Area	65
C	Wild River	69
L_4	Local Area	99
D	Sunday River	51
L_5	Local Area	22
E	Bear River	43
L_6	Local Area	32
F	Ellis River	163
L_7	Local Area	65
G	Swift River	125
H	Swift River plus Local Area	145
L_8	Local Area	323
I	Nezinscot River	181
L_9	Local Area	63
J	Little Androscoggin River	353
L_{10}	Local Area	173
	Androscoggin River above Brunswick	3430

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY | CK. BY

ANDROSCOGGIN RIVER FLOOD CONTROL

BASIN MAP

ANDROSCOGGIN RIVER, MAINE & N.H.

APPROVED — DATE

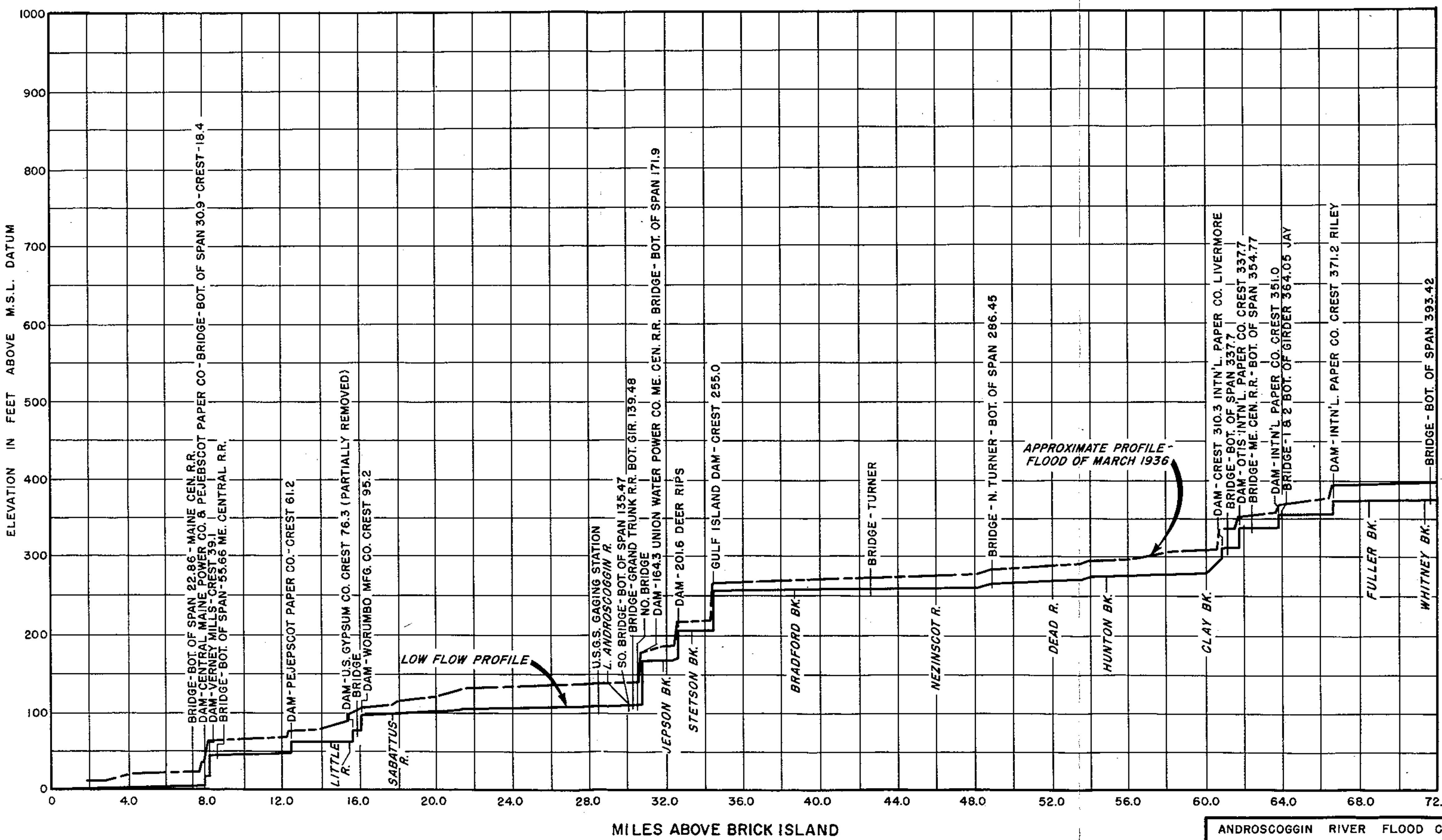
CHIEF, PLANN. & RPTS BRANCH — CHIEF ENGINEERING DIV.

SCALE: AS SHOWN

DRAWING NUMBER

SHEET 1 OF 1

PLATE NO. B-1



ARMY N.E.D. BOSTON OCTOBER 7, 1952

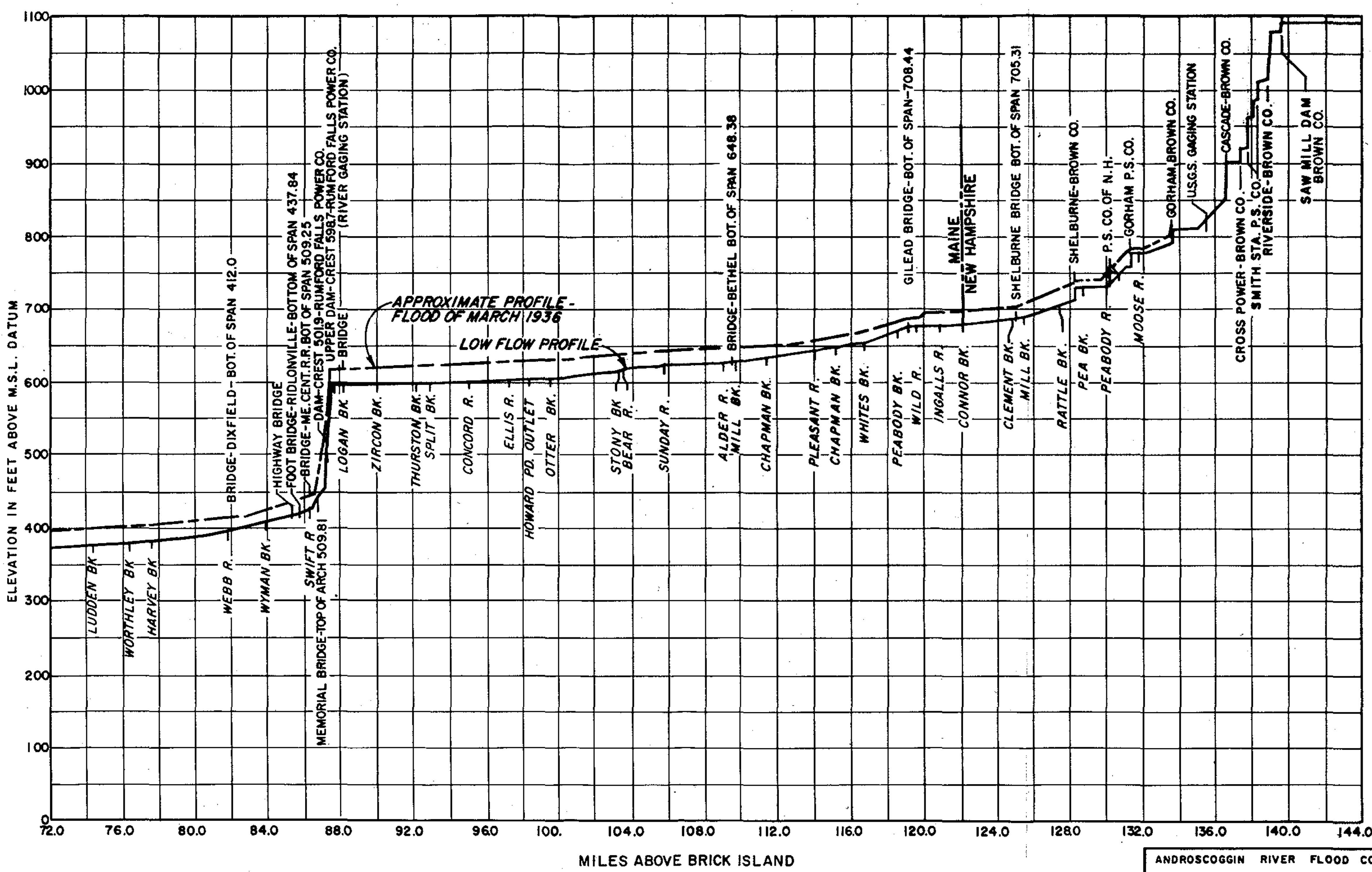
ANDROSCOGGIN RIVER FLOOD CONTROL

ANDROSCOGGIN RIVER PROFILE

ANDROSCOGGIN RIVER MAINE & N.H.

U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS.

PLATE NO. B-2



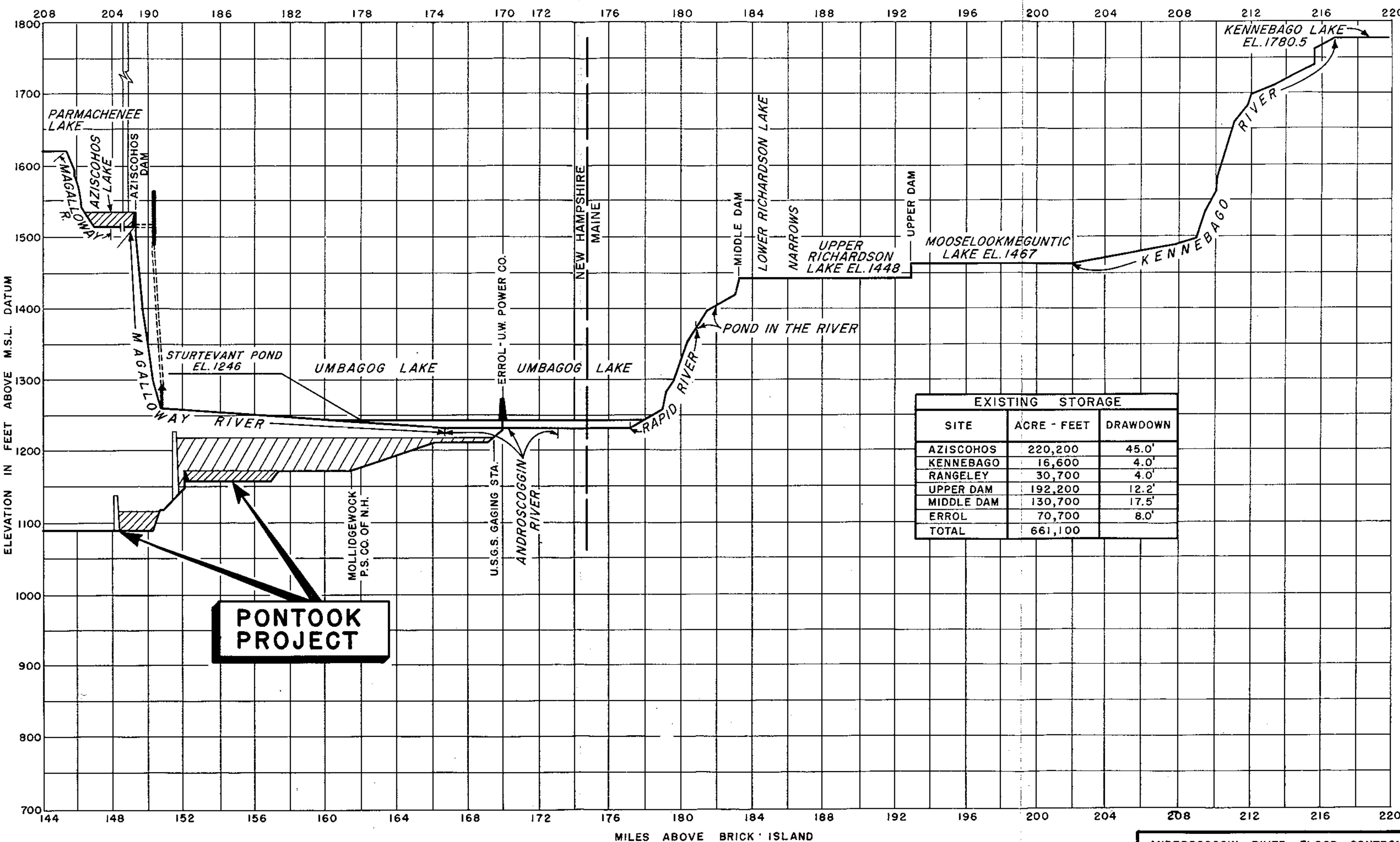
ANDROSCOGGIN RIVER FLOOD CONTROL

ANDROSCOGGIN RIVER PROFILE

ANDROSCOGGIN RIVER — MAINE & N.H.

U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS.

PLATE NO. B-3



EXISTING STORAGE		
SITE	ACRE - FEET	DRAWDOWN
AZISCOHOS	220,200	45.0'
KENNEBAGO	16,600	4.0'
RANGELEY	30,700	4.0'
UPPER DAM	192,200	12.2'
MIDDLE DAM	130,700	17.5'
ERROL	70,700	8.0'
TOTAL	661,100	

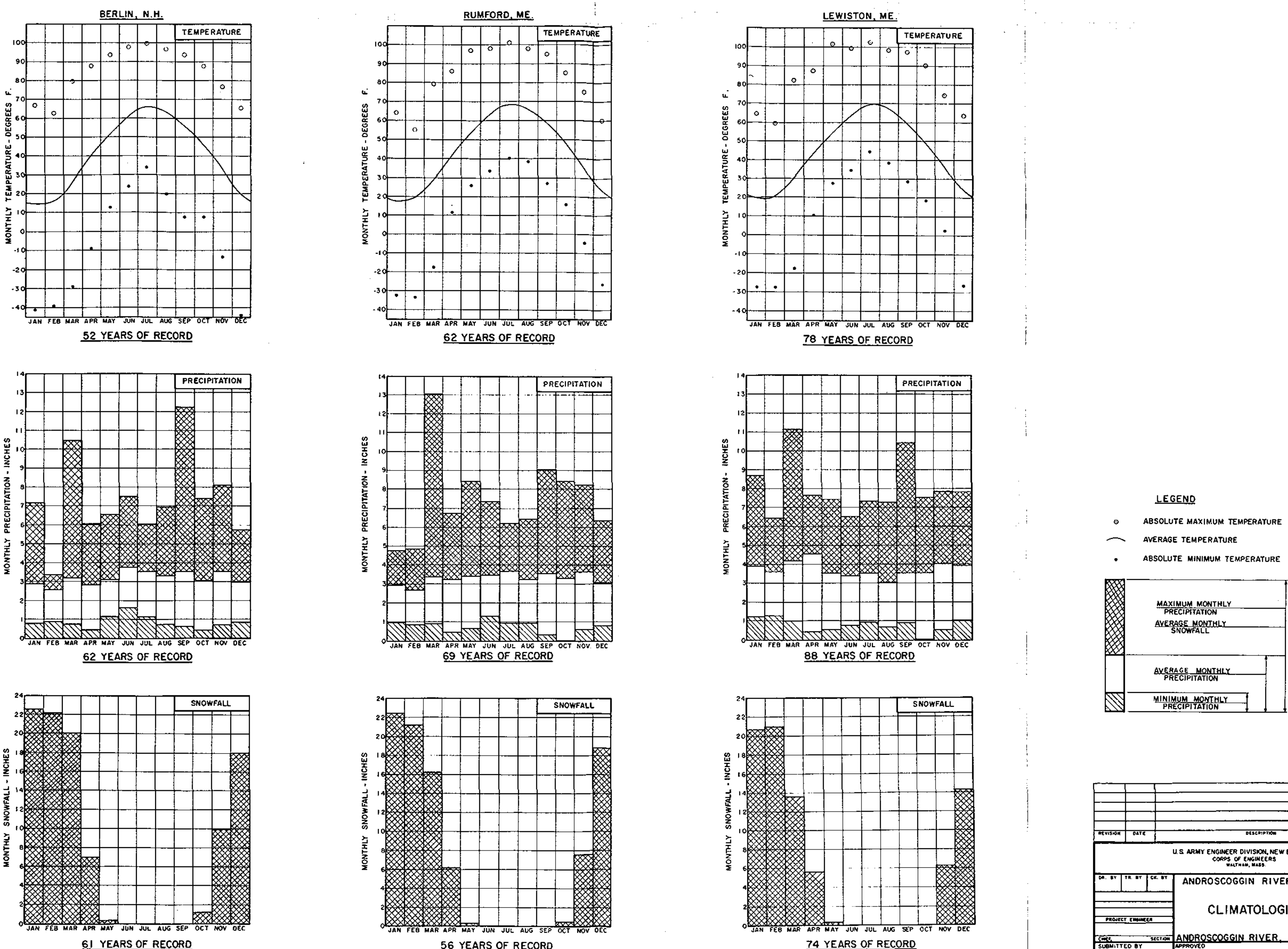
ANDROSCOGGIN RIVER FLOOD CONTROL

ANDROSCOGGIN RIVER PROFILE

ANDROSCOGGIN RIVER MAINE & N.H.

U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS.

PLATE NO. B-4



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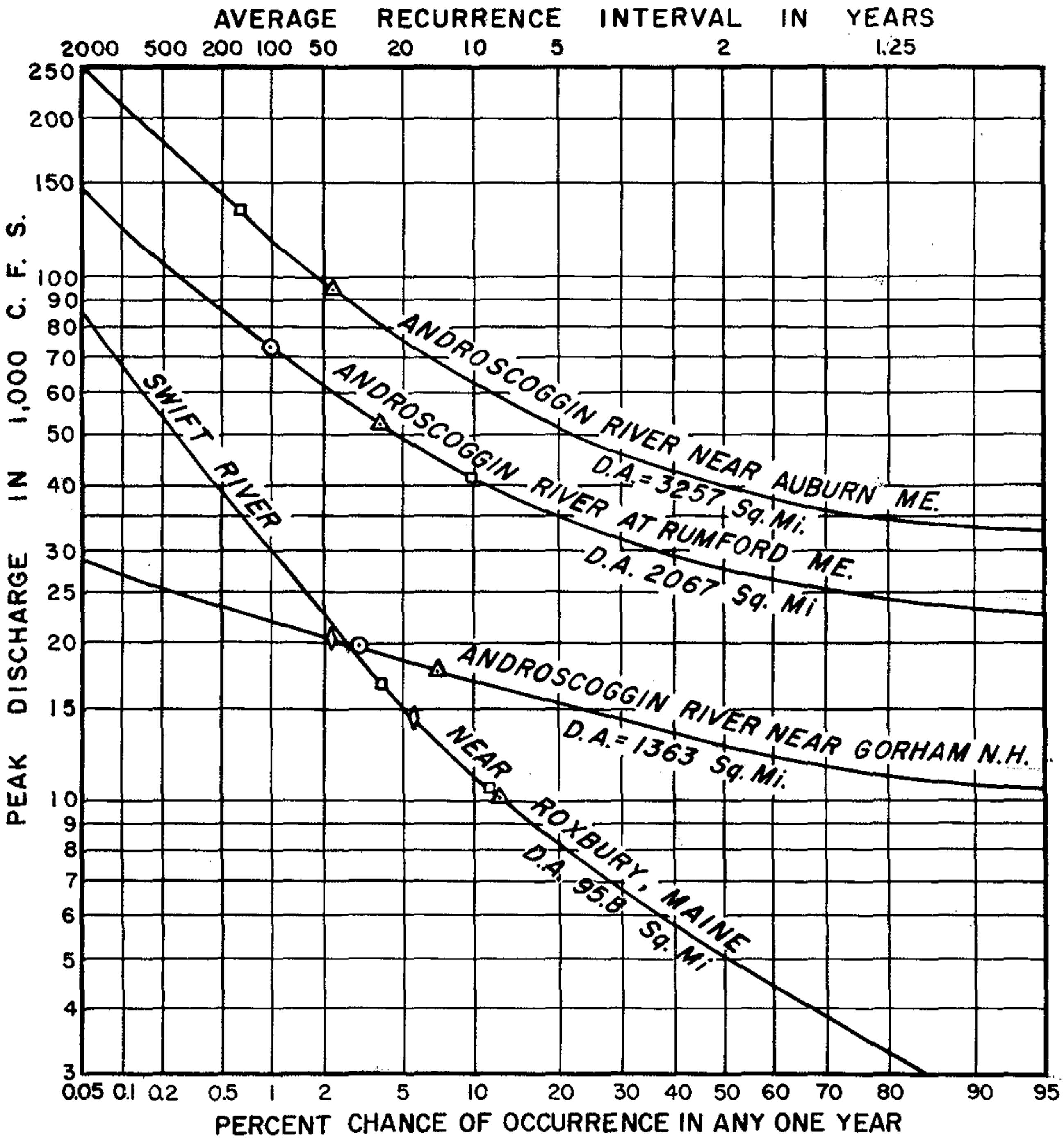
ANDROSCOGGIN RIVER FLOOD CONTROL

CLIMATOLOGICAL DATA

ANDROSCOGGIN RIVER, MAINE & N.H.

SPEC. NO CIV ENG-19-016-



⊙ MARCH 1936 FLOOD
△ MARCH 1953 FLOOD
▫ OCTOBER 1959 FLOOD
◊ OTHER FLOODS OF RECORD

ANDROSCOGGIN RIVER DRAINAGE AREAS INCLUDE 1045 SQ. MI. ABOVE ERROL.

ANDROSCOGGIN RIVER FLOOD CONTROL

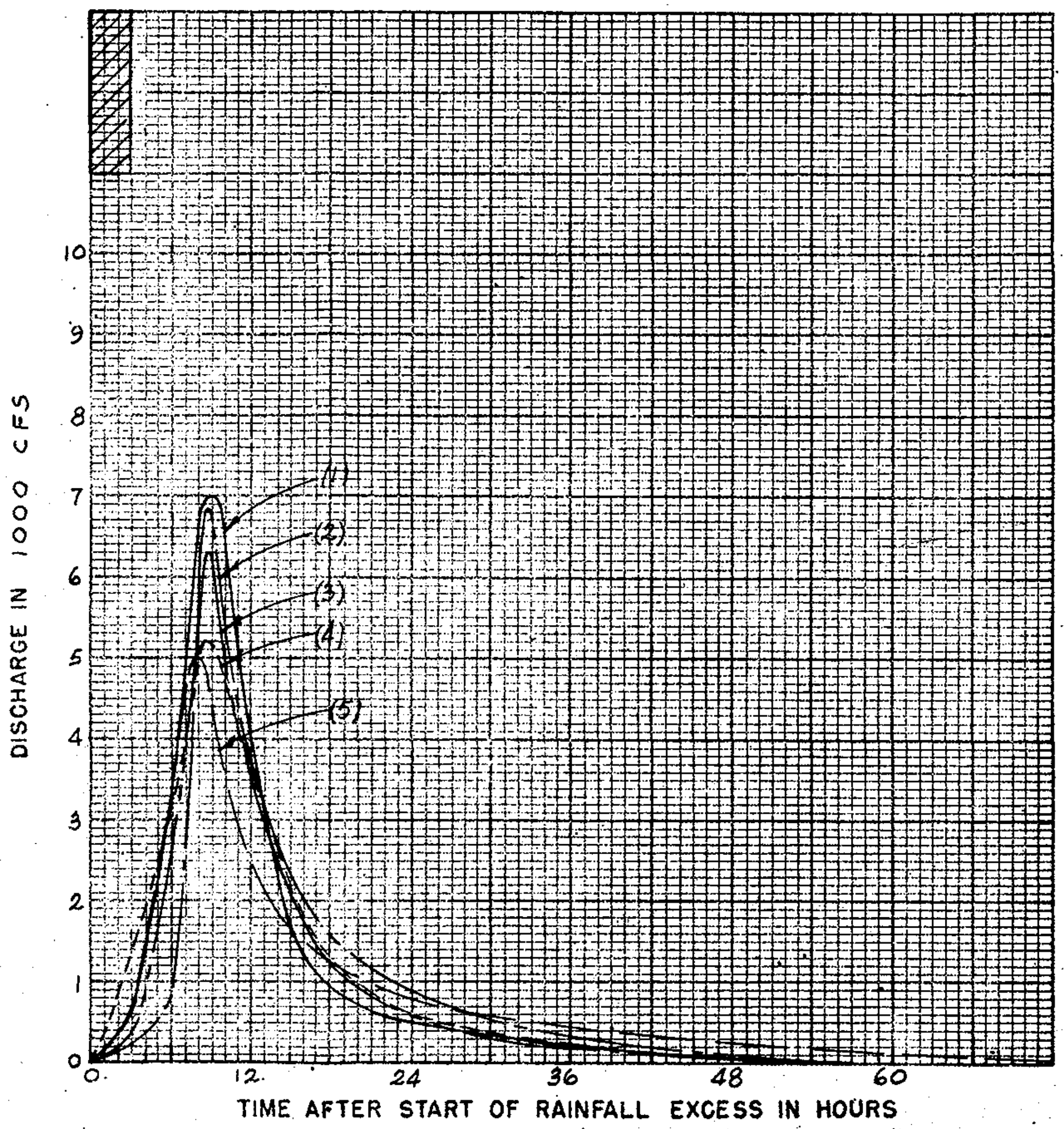
PEAK DISCHARGE FREQUENCY CURVES

ANDROSCOGGIN RIVER MAINE & N.H.

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS

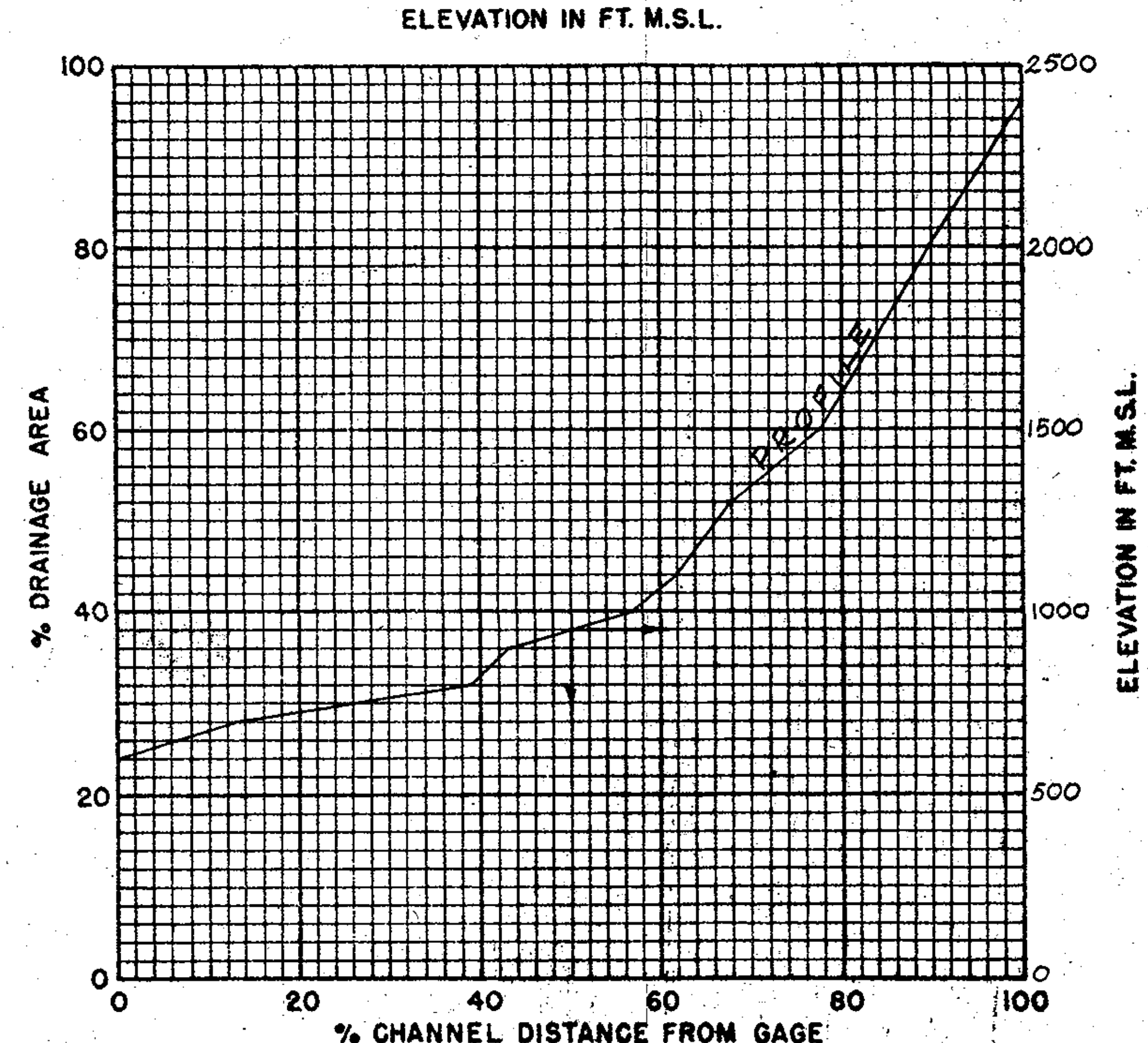
PLATE NO. B-6

OBSERVED UNIT HYDROGRAPHS



DRAINAGE AREA CHARACTERISTICS

DRAINAGE AREA	95.8 sq. mi.	L	19 mi.
MAXIMUM ELEVATION	2400 ft. m.s.l.	L_{ca}	10.8 mi.
MINIMUM ELEVATION	600 ft. m.s.l.	$(LL_{ca})^{0.3}$	4.94
MEAN ELEVATION (weighted)	— ft. m.s.l.	DRAINAGE DENSITY	— mi/sq. mi.
LAND SLOPE	— ft./mi.	MAP SCALE	1:62500
MAIN STREAM SLOPE	64.8 ft./mi.	METHOD OF FLOW SEPARATION	TYPE A
		BASIN SHAPE FACTOR	3.77



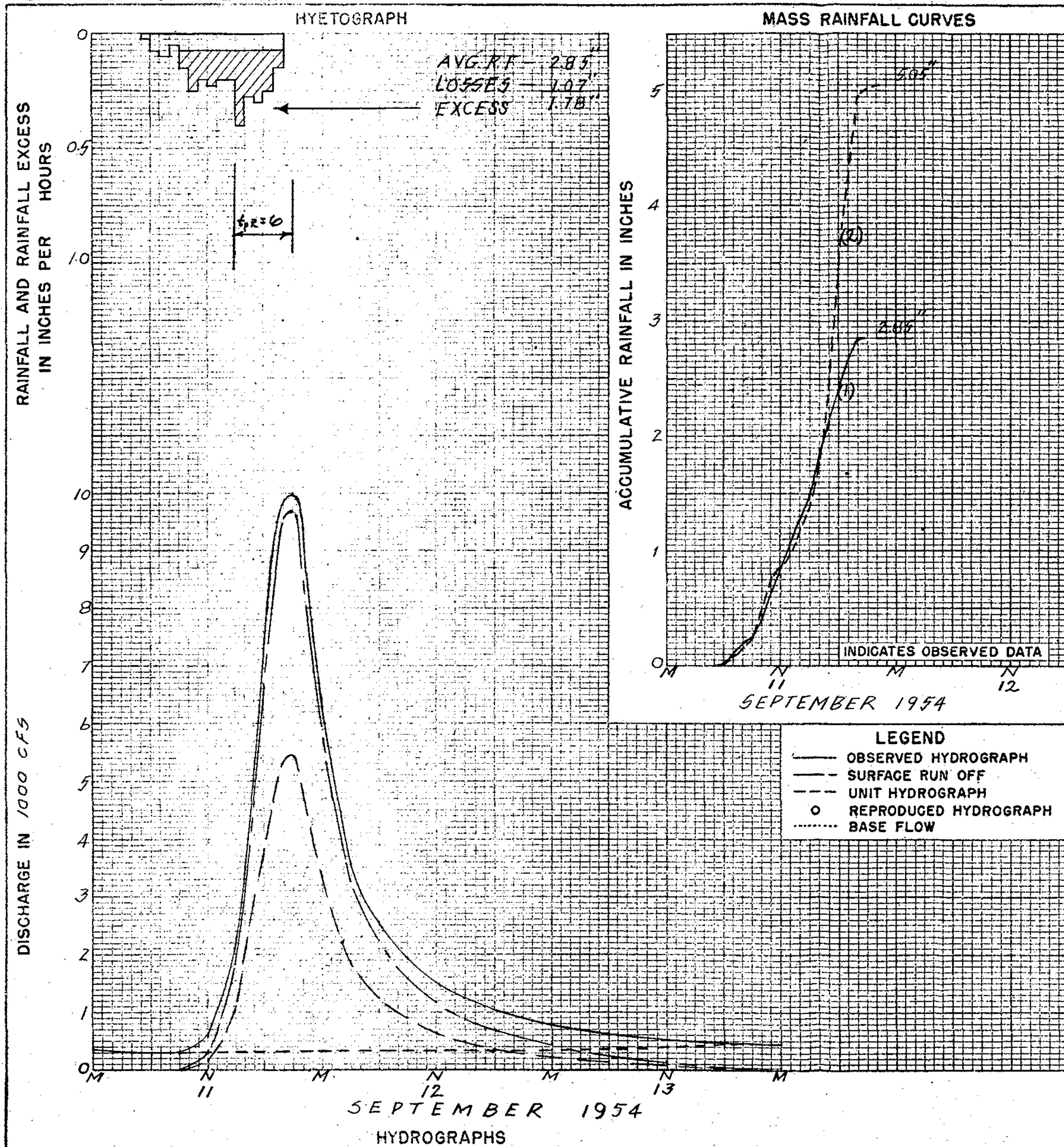
DATA FROM OBSERVED UNIT HYDROGRAPHS

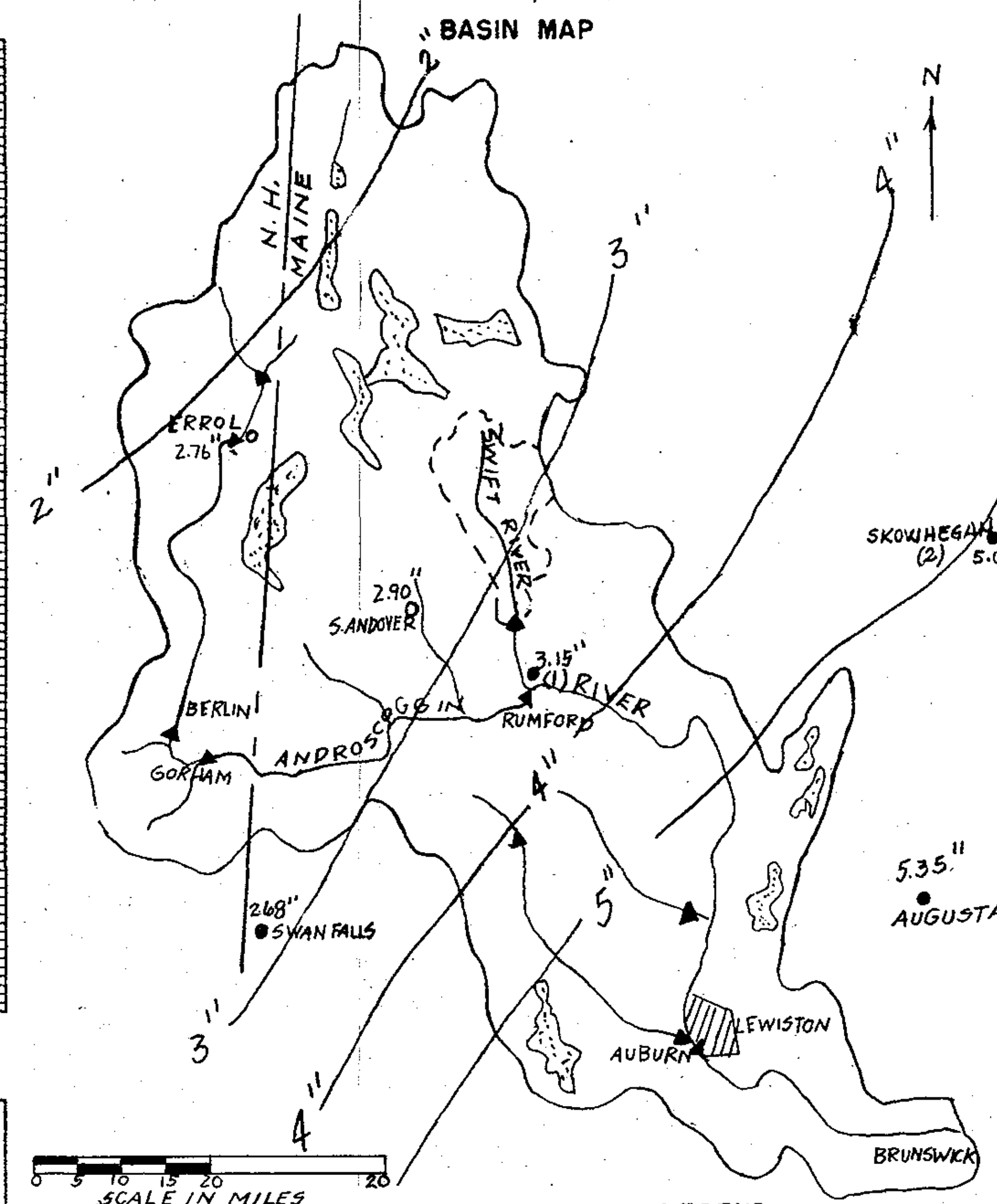
DATE OF RAINFALL	LEGEND	AVE. P (in.)	RAINFALL EXCESS DURATION (hr.)	RAINFALL EXCESS AMOUNT (in.)	L_{cP} (mi.)	STAGE RECORD	Q_{pR} (cfs.)	Q_p tr=3 hrs. (cfs.)	t_{pR} (hr.)	t_p (hr.)	t_v (hr.)	C_{tR}	C_p640	K_m (hr.)	T_ϕ (hr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
SEPT. 11, 1954	(1) ——	2.85	12	1.78	Unifor.	Rec.	5,430	7,000	6.0	7.5		1.52	550		
JUNE 15, 1943	(2) — — -	2.00	3	1.49	Unifor.	Rec.	6,850	6,850	7.0	7.0		1.42	500		
OCT. 23-24, 1959	(3) — — —	4.50	12	2.80	Unifor.	Rec.	5,100	6,300	7.5	8.0		1.62	526		
JUNE 14-15, 1942	(4) - - —	4.94	6	3.08	Unifor.	Rec.	4,800	5,200	8.0	7.0		1.42	380		
NOV. 25-26, 1950	(5) — —	3.54	6	2.78	Unifor.	Rec.	4,100	5,000	7.0	6.5		1.32	339		

ENGINEERING INVESTIGATIONS
UNIT HYDROGRAPHS

SWIFT RIVER NEAR
ROXBURY, MAINE

PERTINENT DATA





LEGEND

	REC.	NON REC.
PRECIPITATION GAGES	●	○
STREAM GAGES	▲	△
ISOHYETS	———	———
THIESSEN POLYGON	- - - - - - - -	
ZONE BOUNDARY		

BASIC DATA
(Sheet 1 of 2)

ENGINEERING INVESTIGATIONS
UNIT HYDROGRAPHS

SWIFT RIVER NEAR
ROXBURY, MAINE

STORM OF SEPTEMBER 11, 1954

DEPARTMENT OF THE ARMY

UNIT HYDROGRAPH BASIC DATA SHEET

CORPS OF ENGINEERS

(7) STREAM AND STATION Swift River near Roxbury, Maine LAT. 44°38'30" LONG. 70°35'15"

(8) DATE OF STORM September 11, 1954 (9) OFFICE New England Division

(10) DRAINAGE AREA 95.8 SQ.MI. (11) L 19 MI. (12) L_{ca} 10.8 MI. (13) $(LL_{ca})^{0.3}$ 4.94

(14) AVERAGE RAINFALL 2.85 IN. (15) t_R 12 HRS. (16) DIRECT RUNOFF 1.78 IN.

(17) Q_{pR} 5,430 CFS. (18) q_{pR} 56.5 CFS/SQ.MI. (19) Q_p 7,000 CFS. (20) t_{pR} 6 HRS.

(21) t_p 7.5 HRS. (22) t_v ____ HRS. (23) C_{tR} 1.52 (24) C_p640 550 W_{50} 6.5 HRS. W_{75} 4 HRS.

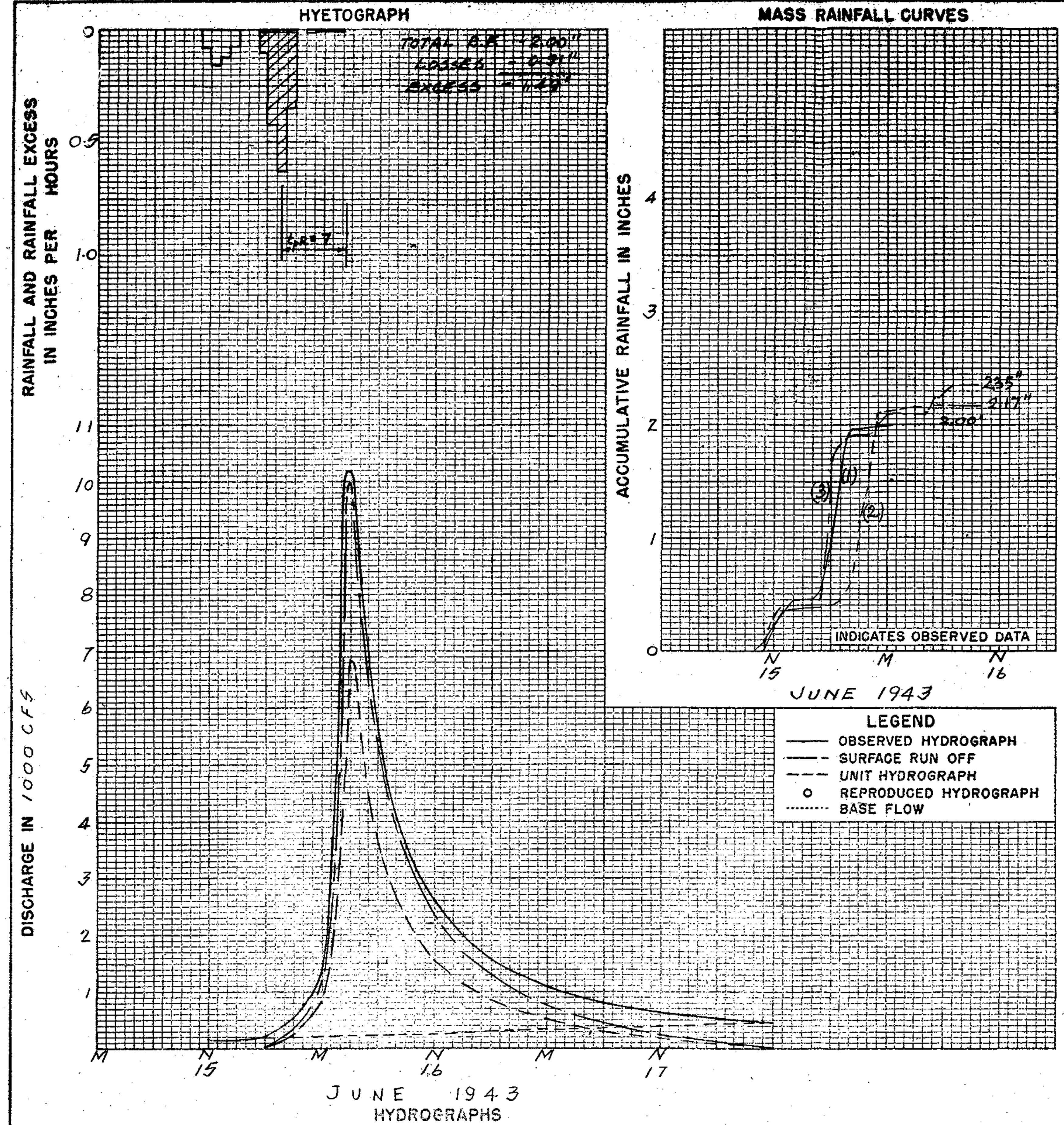
TIME Sept. 1954 (25)	OBSERVED DISCHARGE (1000 CFS) (26)	ESTIMATED BASE FLOW (1000 CFS) (27)	DIRECT RUNOFF (1000 CFS) (28)	OBSERVED 12 HR UNIT HYDROGRAPH (1000 CFS) (29)	ADJUSTED 3 HR UNIT HYDROGRAPH (1000 CFS) (30)	REPRODUCED STORM HYDROGRAPH (1000 CFS) (31)	(32)	(33)
11-9A	300	300	0	0	0			
N	600	300	300	170	680			
3P	2160	300	1860	1050	3520			
6	6960	300	6660	3740	7000			
9	9970	310	9660	5430	4200			
M	6280	310	5970	3360	1560			
12-3A	3580	310	3270	1840	720			
6	2540	320	2220	1250	660			
9	1910	320	1590	900	500			
N	1520	330	1190	670	400			
3P	1220	340	880	500	300			
6	1050	350	700	390	260			
9	900	360	540	300	200			
M	795	370	425	240	160			
13-3A	700	380	320	180	120			
6	620	390	230	130	80			
9	580	390	190	110	60			
N	520	400	120	70	40			
3P	500	410	90	50	20			
6	490	430	60	30	0			
9	480	450	30	20	0			
M	470	470	0	0	0			
Totals	114145	7840	36305	20430	20480			

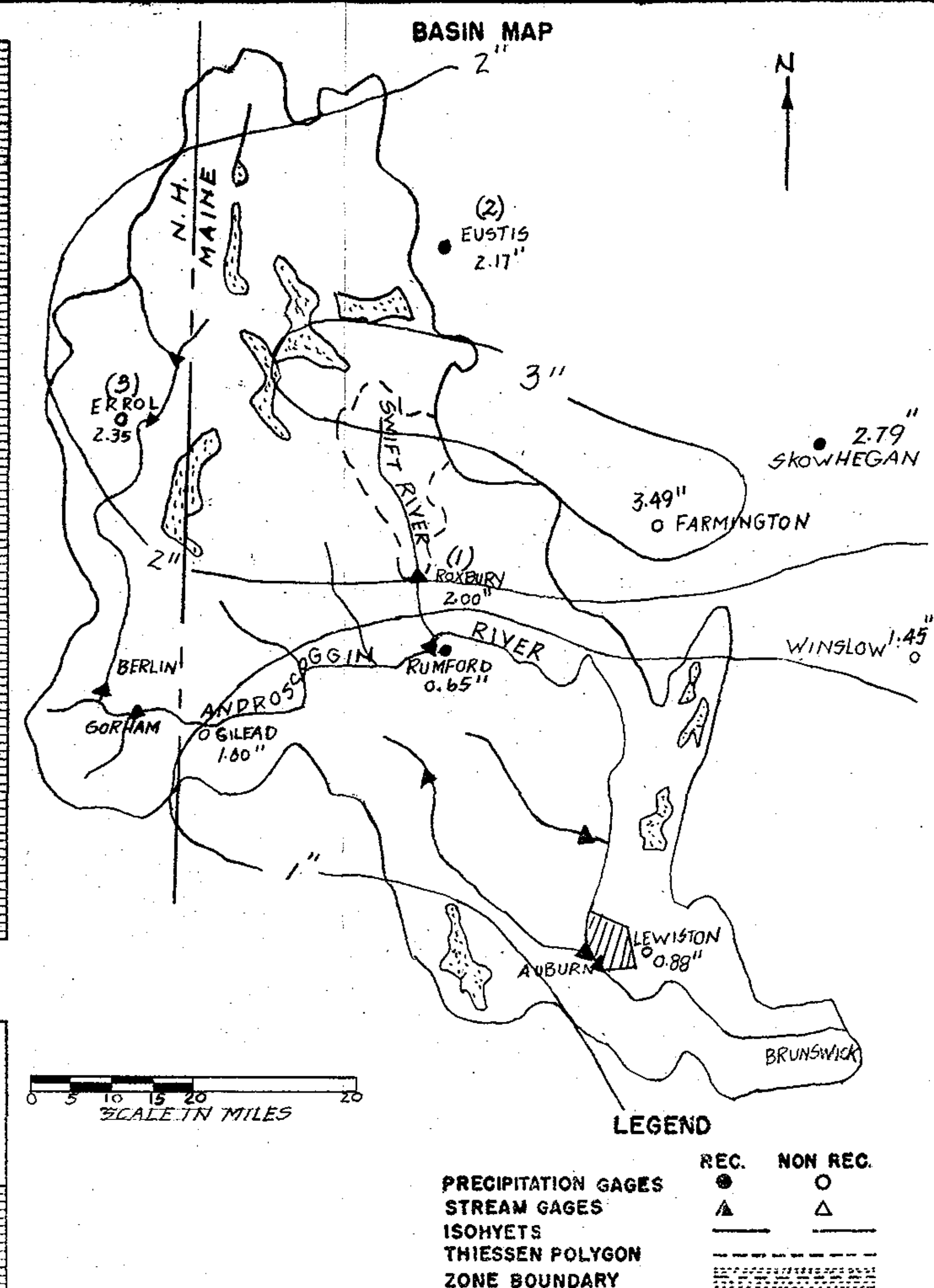
DATE | COMPUTED BY

ENG FORM 1 NOV 49 1823

Plate No. B-9

C51636





BASIC DATA
(Sheet 1 of 2)

ENGINEERING INVESTIGATIONS
UNIT HYDROGRAPHS

SWIFT RIVER NEAR
ROXBURY, MAINE

STORM OF JUNE 15, 1943

DEPARTMENT OF THE ARMY

UNIT HYDROGRAPH BASIC DATA SHEET

CORPS OF ENGINEERS (SHEET 2 OF 2)

(7) STREAM AND STATION Swift River near Roxbury, Maine LAT. 44°38'30" LONG. 70°35'15"

(8) DATE OF STORM June 15, 1943 (9) OFFICE New England Division

(10) DRAINAGE AREA 95.8 SQ.MI. (11) L 19 MI. (12) L_{ca} 10.8 MI. (13) $(LL_{ca})^{0.3}$ 4.94

(14) AVERAGE RAINFALL 2.00 IN. (15) t_R 3 HRS. (16) DIRECT RUNOFF 1.49 IN.

(17) Q_{pR} 6850 CFS. (18) q_{pR} 71.5 CFS/SQ.MI. (19) Q_p 6,850 CFS. (20) t_{pR} 7 HRS.

(21) t_p 7 HRS. (22) t_v ___ HRS. (23) C_{tR} 1.42 (24) $C_p 640$ 500 W_{50} 5 HRS. W_{75} 2.5 HRS.

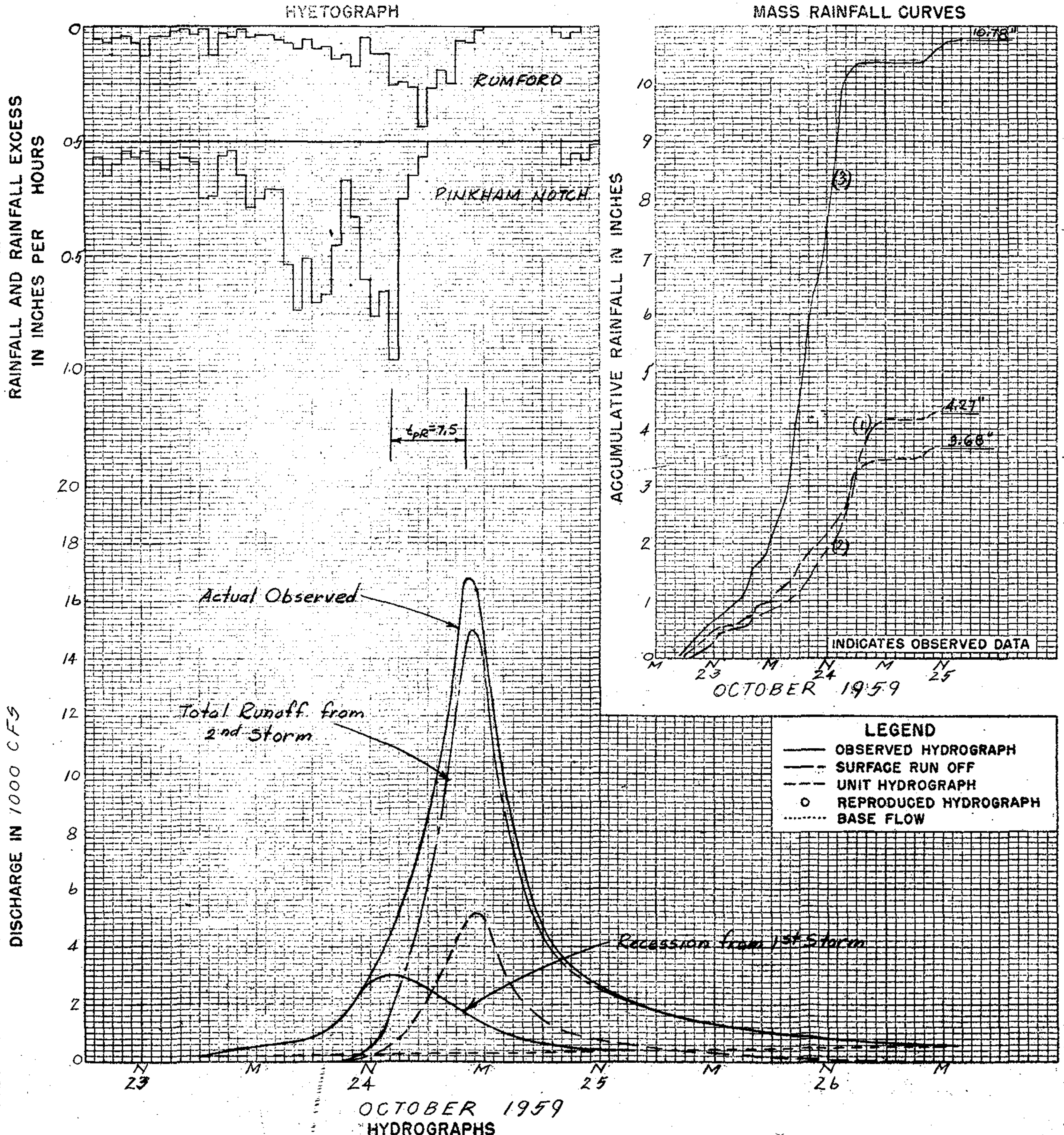
TIME June 1943 (25)	OBSERVED DISCHARGE (1000 CFS) (26)	ESTIMATED BASE FLOW (1000 CFS) (27)	DIRECT RUNOFF (1000 CFS) (28)	OBSERVED 3 HR UNIT HYDROGRAPH (1000 CFS) (29)	ADJUSTED ___ HR UNIT HYDROGRAPH (1000 CFS) (30)	REPRODUCED STORM HYDROGRAPH (1000 CFS) (31)	(32)	(33)
15-6P	200	200	0	0				
9	530	200	330	220				
M	1400	200	1200	810				
16-3A	10000	220	9780	6580				
6	5700	240	5460	3670				
9	3680	260	3420	2300				
N	2600	280	2320	1560				
3P	1980	300	1680	1130				
6	1590	310	1280	860				
9	1300	320	980	660				
M	1100	330	770	520				
17-3A	940	340	600	400				
6	820	360	460	310				
9	720	370	350	230				
N	640	380	260	180				
3P	590	390	200	130				
6	530	400	130	90				
9	500	430	70	40				
M	470	470	0	0				
Totals	35290	6000	29290	19690				

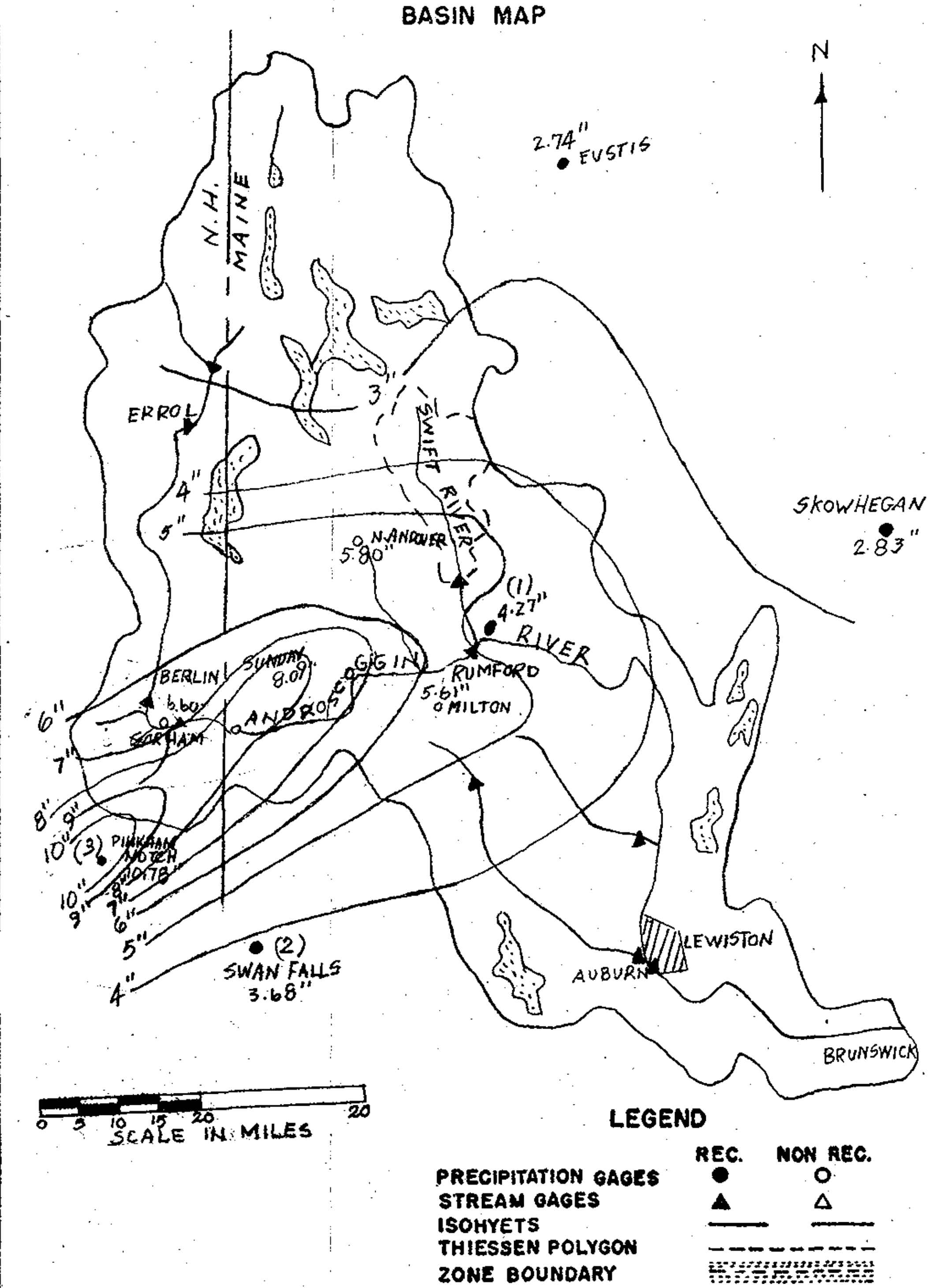
DATE COMPUTED BY

ENG FORM 1 NOV 49 1823

Plate No. B-11

C51636





BASIC DATA
(Sheet 1 of 2)

ENGINEERING INVESTIGATIONS
UNIT HYDROGRAPHS

SWIFT RIVER NEAR
ROXBURY, MAINE

STORM OF OCTOBER 23-24, 1959

Plate No. B-12

DEPARTMENT OF THE ARMY

UNIT HYDROGRAPH BASIC DATA SHEET

CORPS OF ENGINEERS (SHEET 2 OF 2)

(7) STREAM AND STATION Swift River near Roxbury, Maine LAT. 44°38'30" LONG. 70°35'15"

(8) DATE OF STORM October 23-24, 1959 (9) OFFICE New England Division

(10) DRAINAGE AREA 95.8 SQ.MI. (11) L 19 MI. (12) L_{ca} 10.8 MI. (13) $(LL_{ca})^{0.3}$ 4.94

(14) AVERAGE RAINFALL 4.50 IN. (15) t_R 12 HRS. (16) DIRECT RUNOFF 2.80 IN.

(17) Q_{pR} 5,100 CFS. (18) q_{pR} 53 CFS/SQ.MI. (19) Q_p 6,300 CFS. (20) t_{pR} 7.5 HRS.

(21) t_p 8 HRS. (22) t_v HRS. (23) C_{tR} 1.62 (24) $C_p{}^{640}$ 526 W_{50} 7 HRS. W_{75} 4.5 HRS.

TIME OCT 1959 (25)	OBSERVED DISCHARGE (1000 CFS) (26)	ESTIMATED BASE FLOW (1000 CFS) (27)	DIRECT RUNOFF (1000 CFS) (28)	OBSERVED 12 HR UNIT HYDROGRAPH (1000 CFS) (29)	ADJUSTED 3 HR UNIT HYDROGRAPH (1000 CFS) (30)	REPRODUCED STORM HYDROGRAPH (1000 CFS) (31)	(32)	(33)
23 6P	200	200	0		0			
9	200	200	0		360			
M	200	200	0		2,800			
24 3A	210	210	0		6,240			
6	220	220	0		4,600			
9	230	230	0	0	2,000			
N	500	250	250	90	1,200			
3P	2,500	280	2,220	790	800			
6	6,270	300	5,970	2,130	580			
9	12,200	300	11,900	4,250	460			
M	13,970	310	13,660	4,890	360			
25 3A	7,520	330	7,190	2,570	300			
6	4,370	350	4,020	1,440	240			
9	3,170	370	2,800	1,000	200			
N	2,570	390	2,180	780	140			
3P	2,150	400	1,750	630	120			
6	1,800	420	1,380	490	80			
9	1,540	440	1,100	390	60			
M	1,340	460	880	310	40			
26 3A	1,180	470	710	250	20			
6	1,020	480	540	190	0			
9	920	500	420	150				
N	830	510	320	110				
3P	750	540	210	70				
6	700	570	130	50				
9	640	580	60	20				
M	600	600	0	0				
Totals	67800	10110	57690	20600	20600			

DATE

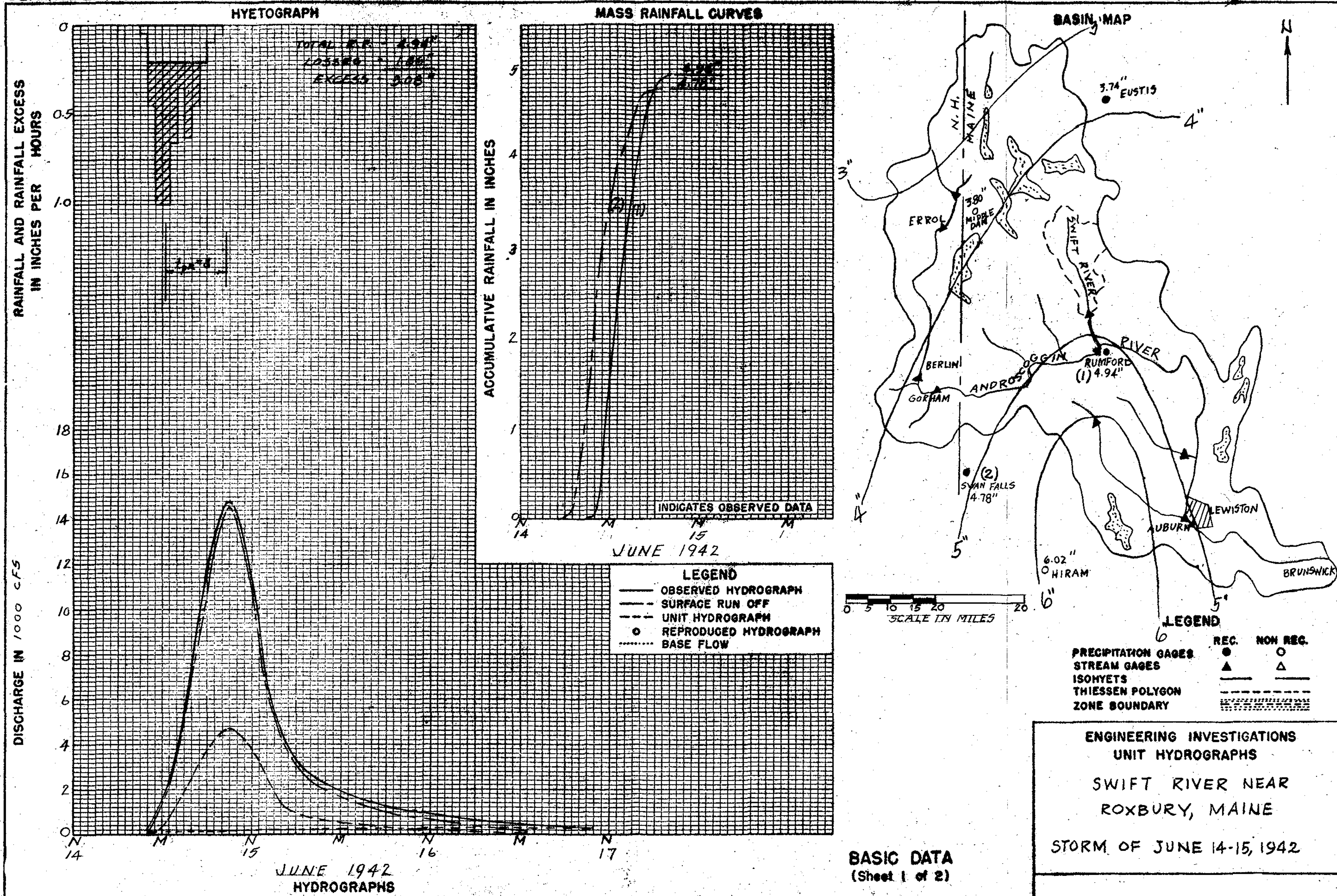
COMPUTED BY

ENG FORM 1 NOV 49 1823

Plate No. B-13

CS1636

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS



BASIC DATA
(Sheet 1 of 2)

ENGINEERING INVESTIGATIONS
UNIT HYDROGRAPHS

SWIFT RIVER NEAR
ROXBURY, MAINE

STORM OF JUNE 14-15, 1942

Plate No. B-14

DEPARTMENT OF THE ARMY

UNIT HYDROGRAPH BASIC DATA SHEET

CORPS OF ENGINEERS

(SHEET 2 OF 2)

(7) STREAM AND STATION Swift River near Roxbury, Maine LAT. 44°38'30" LONG. 70°35'15"

(8) DATE OF STORM June 14-15, 1942 (9) OFFICE New England Division

(10) DRAINAGE AREA 95.8 SQ.MI. (11) L 19 MI. (12) L_{ca} 10.8 MI. (13) $(LL_{ca})^{0.3}$ 4.94

(14) AVERAGE RAINFALL 4.94 IN. (15) t_R 6 HRS. (16) DIRECT RUNOFF 3.08 IN.

(17) Q_{pR} 4800 CFS. (18) q_{pR} 50 CFS/SQ.MI. (19) Q_p 5,200 CFS. (20) t_{pR} 8 HRS.

(21) t_p 7 HRS. (22) t_v ___ HRS. (23) C_{tR} 1.42 (24) $C_p 640$ 380 W_{50} 9 HRS. W_{75} 5 HRS.

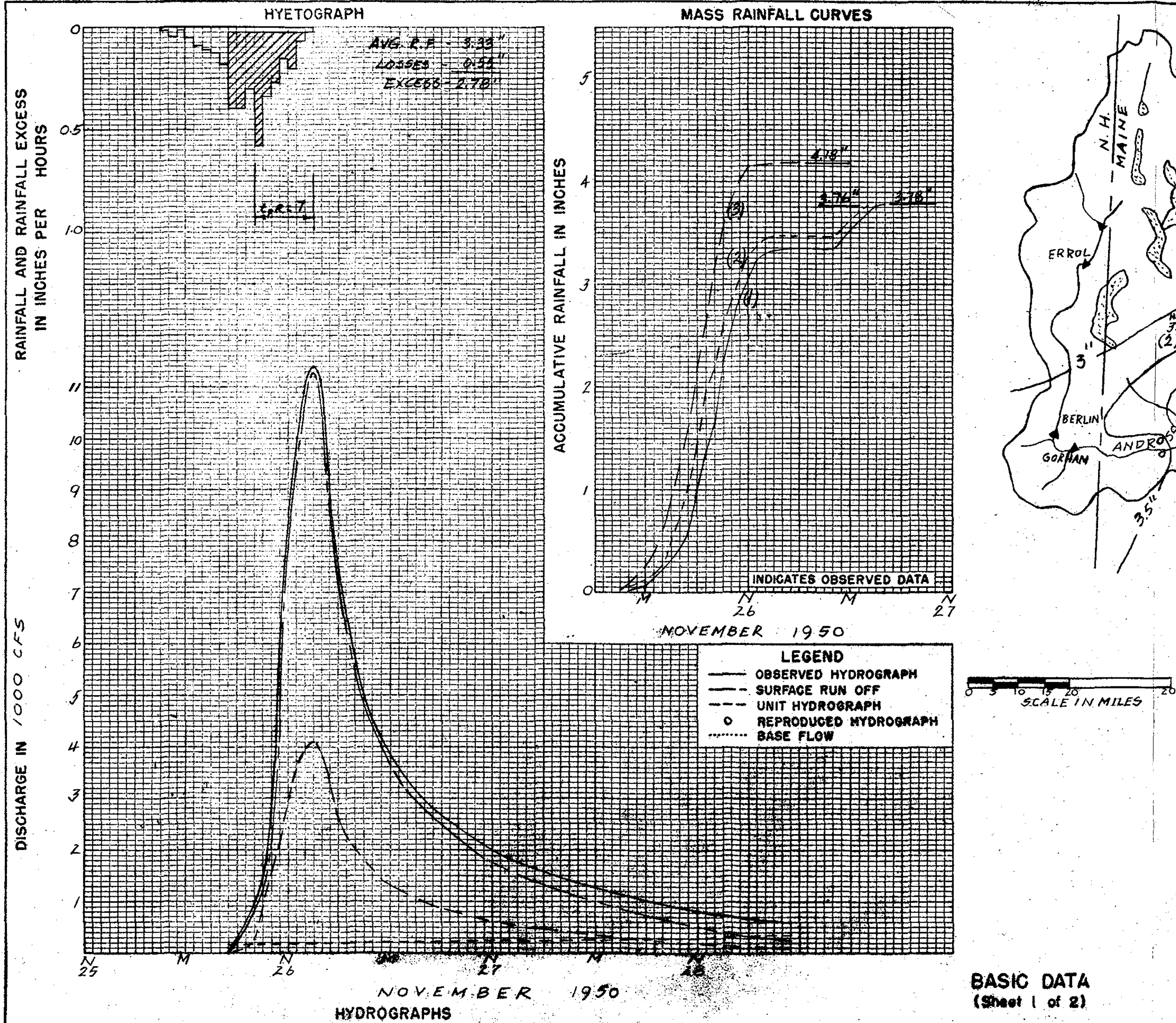
TIME June 1942 (25)	OBSERVED DISCHARGE (1000 CFS) (26)	ESTIMATED BASE FLOW (1000 CFS) (27)	DIRECT RUNOFF (1000 CFS) (28)	OBSERVED 6 HR UNIT HYDROGRAPH (1000 CFS) (29)	ADJUSTED 3 HR UNIT HYDROGRAPH (1000 CFS) (30)	REPRODUCED STORM HYDROGRAPH (1000 CFS) (31)	(32)	(33)
14-10P	200	150	0	0	0			
15-1A	2400	150	2250	730	1460			
4	7600	150	7450	2420	3280			
7	13150	150	13000	4200	5120			
10	14100	200	13900	4510	3880			
1P	10500	200	10300	3330	2120			
4	4500	200	4300	1400	1280			
7	2880	200	2680	870	820			
10	2250	250	2000	650	560			
16-1A	1790	250	1540	500	440			
4	1450	250	1200	390	340			
7	1210	250	960	310	300			
10	1050	250	800	260	260			
1P	870	250	620	200	160			
4	740	250	490	160	140			
7	610	300	310	100	120			
10	550	300	250	80	100			
17-1A	450	300	150	50	60			
4	390	300	90	30	40			
7	330	300	30	10	0			
10	300	300	0	0	0			
Totals	67320	4950	62320	20200	20480			

DATE

COMPUTED BY

ENG FORM 1 NOV 49 1823

Plate No. B-15 C51636



BASIC DATA
(Sheet 1 of 2)

ENGINEERING INVESTIGATIONS
UNIT HYDROGRAPHS

SWIFT RIVER NEAR
ROXBURY, MAINE

STORM OF NOVEMBER 25,26, 1950

DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

UNIT HYDROGRAPH BASIC DATA SHEET

(SHEET 2 OF 2)

(7) STREAM AND STATION Swift River near Roxbury, Maine LAT. 44°38'30" LONG. 70°35'15"

(8) DATE OF STORM November 25, 26, 1950 (9) OFFICE New England Division

(10) DRAINAGE AREA 95.8 SQ.MI. (11) L 19 MI. (12) L_{ca} 10.8 MI. (13) $(LL_{ca})^{0.3}$ 4.94

(14) AVERAGE RAINFALL 3.54 IN. (15) t_R 6 HRS. (16) DIRECT RUNOFF 2.78 IN.

(17) Q_{pR} 4,100 CFS. (18) q_{pR} 43 CFS/SQ.MI. (19) Q_D 5,000 CFS. (20) t_{pR} 7 HRS.

(21) t_p 6.5 HRS. (22) t_v ___ HRS. (23) C_{tR} 1.32 (24) C_p640 339 W_{50} 7 HRS. W_{75} 3.5 HRS.

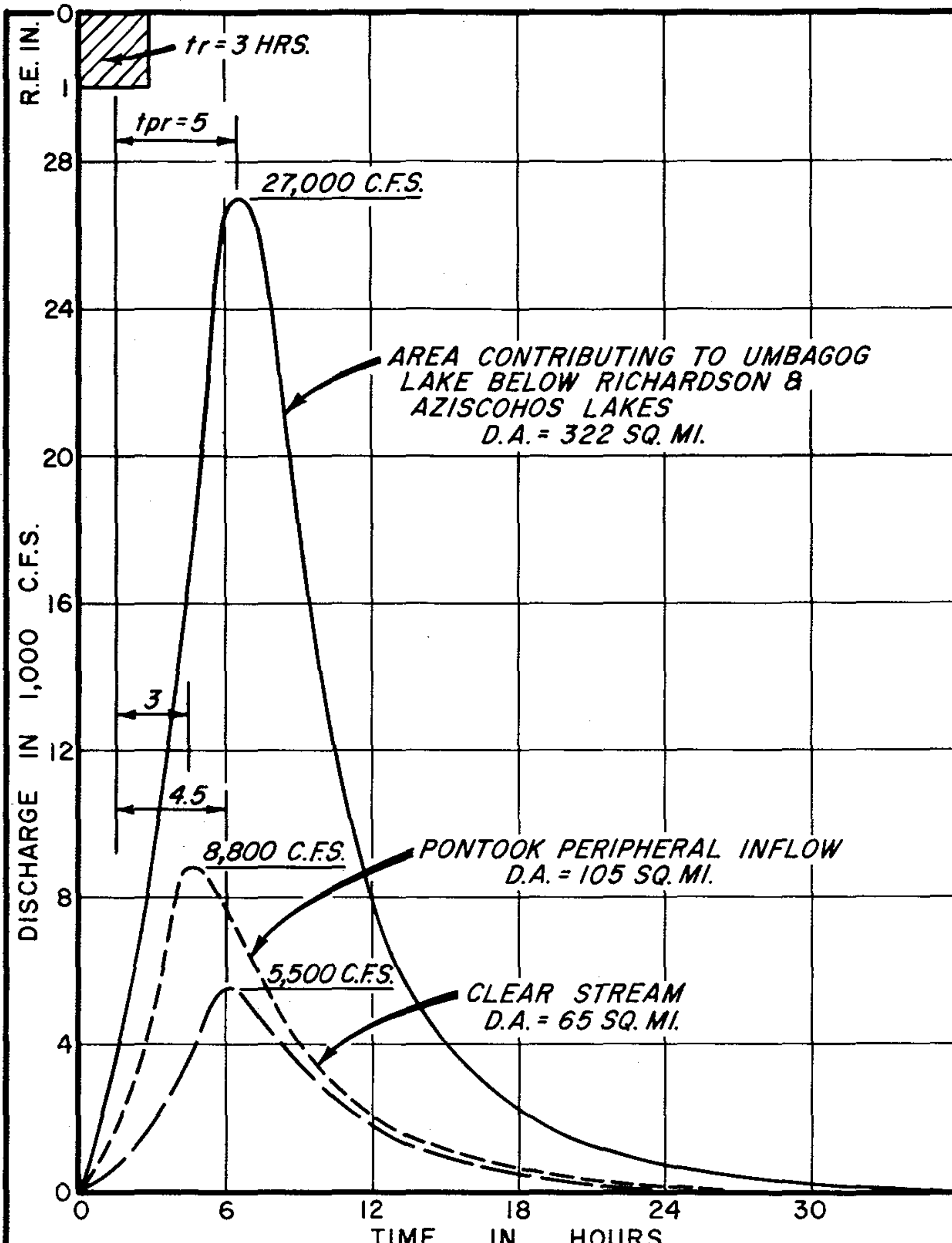
TIME NOV. 1950 (25)	OBSERVED DISCHARGE (1000 CFS) (26)	ESTIMATED BASE FLOW (1000 CFS) (27)	DIRECT RUNOFF (1000 CFS) (28)	OBSERVED 6 HR UNIT HYDROGRAPH (1000 CFS) (29)	ADJUSTED 3 HR UNIT HYDROGRAPH (1000 CFS) (30)	REPRODUCED STORM HYDROGRAPH (1000 CFS) (31)	(32)	(33)
26-5A	0	180	0	0	0			
8	980	180	800	290	580			
11	6000	190	5810	2090	3620			
2P	11050	190	10860	3900	4400			
5	9700	200	9500	3420	2360			
8	5800	200	5600	2020	1640			
11	4220	210	4010	1450	1260			
27-2A	3360	210	3150	1130	1040			
5	2820	220	2600	930	850			
8	2470	230	2240	810	660			
11	2120	250	1870	670	580			
2P	1880	250	1630	590	520			
5	1680	260	1420	510	500			
8	1490	270	1220	440	420			
11	1320	280	1040	370	360			
28-2A	1190	290	900	320	300			
5	1080	300	780	280	240			
8	980	300	680	240	200			
11	870	310	560	200	180			
2P	790	320	470	170	140			
5	700	340	360	130	120			
8	650	350	300	110	80			
11	600	360	240	90	80			
29-2A	530	370	160	60	60			
5	500	380	120	40	20			
8	450	390	60	20	0			
11	400	400	0	0	0			
Totals	63630	7430	56380	20280	20220			

DATE

COMPUTED BY

ENG FORM 1 NOV 49 1823

C 51636



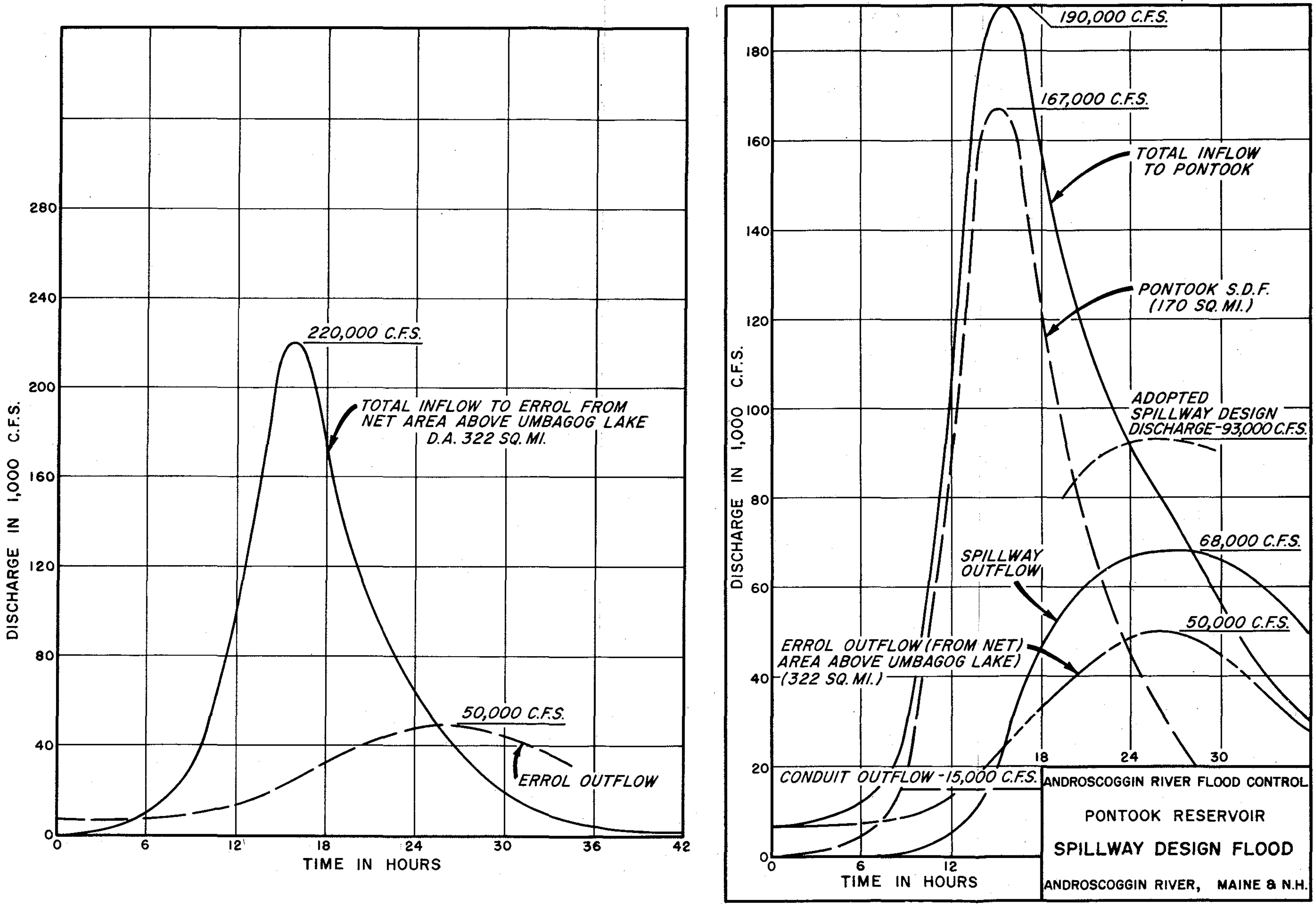
ANDROSCOGGIN RIVER FLOOD CONTROL

PONTOOK RESERVOIR

ADOPTED THREE HOUR UNIT HYDROGRAPHS

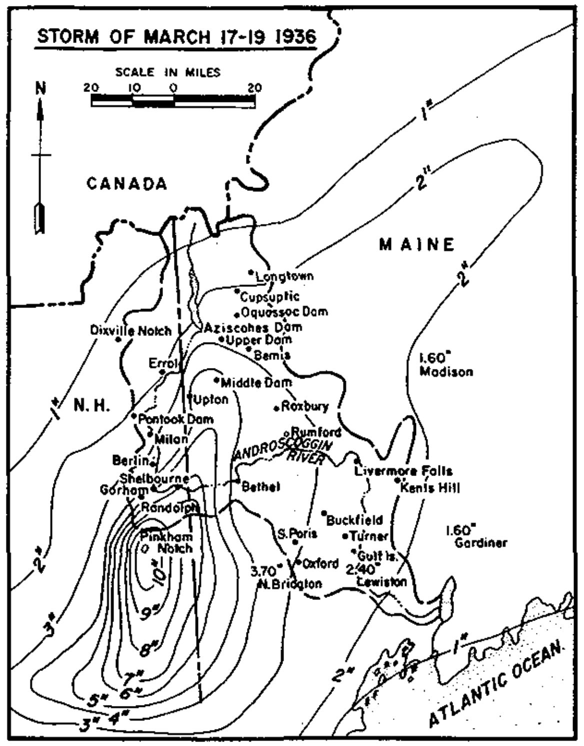
ANDROSCOGGIN RIVER, MAINE & N.H.

PLATE NO. B-18

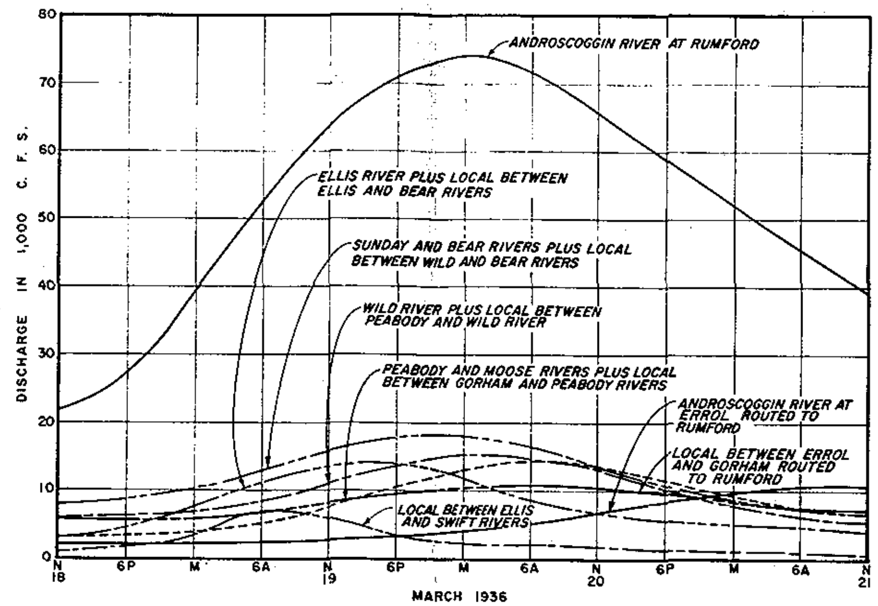


220,000 C.F.S.
TOTAL INFLOW TO ERROL FROM NET AREA ABOVE UMBAGOG LAKE D.A. 322 SQ. MI.
50,000 C.F.S.
ERROL OUTFLOW
DISCHARGE IN 1,000 C.F.S.
TIME IN HOURS
190,000 C.F.S.
167,000 C.F.S.
TOTAL INFLOW TO PONTOOK
PONTOOK S.D.F. (170 SQ. MI.)
ADOPTED SPILLWAY DESIGN DISCHARGE-93,000 C.F.S.
68,000 C.F.S.
SPILLWAY OUTFLOW
50,000 C.F.S.
ERROL OUTFLOW (FROM NET) AREA ABOVE UMBAGOG LAKE) (322 SQ. MI.)
CONDUIT OUTFLOW-15,000 C.F.S.
ANDROSCOGGIN RIVER FLOOD CONTROL
PONTOOK RESERVOIR
SPILLWAY DESIGN FLOOD
ANDROSCOGGIN RIVER, MAINE & N.H.

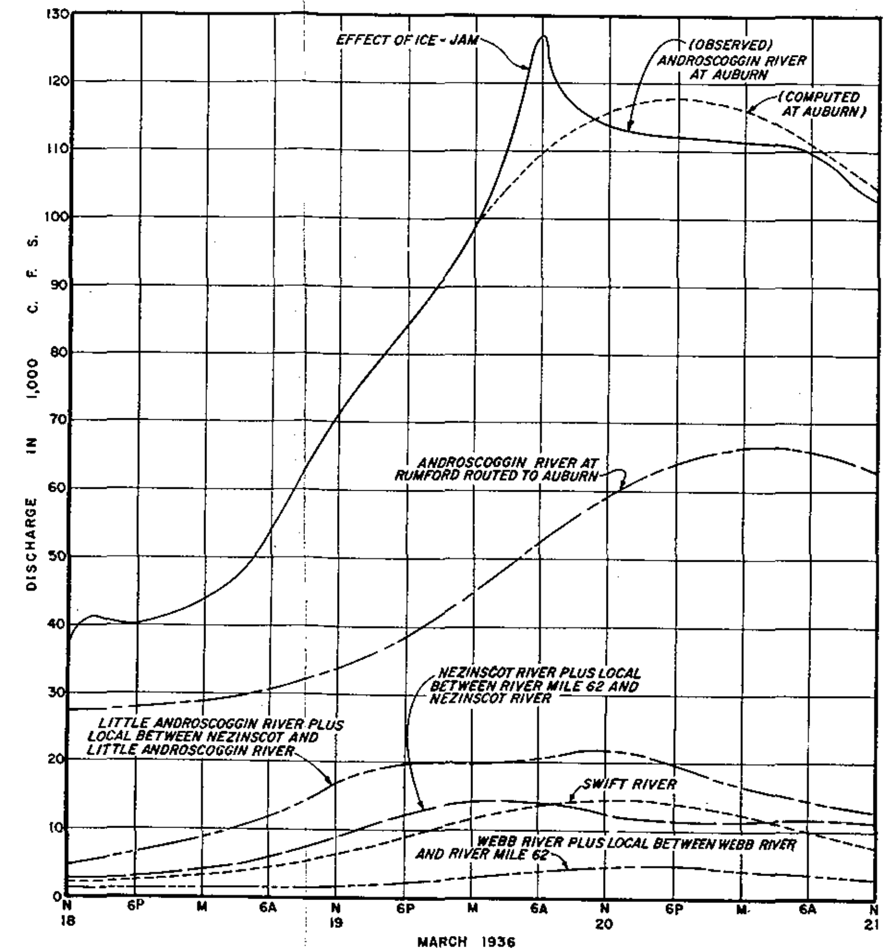
PLATE NO. B-19



ISOHYETAL MAP



ANDROSCOGGIN RIVER AT RUMFORD



ANDROSCOGGIN RIVER AT AUBURN

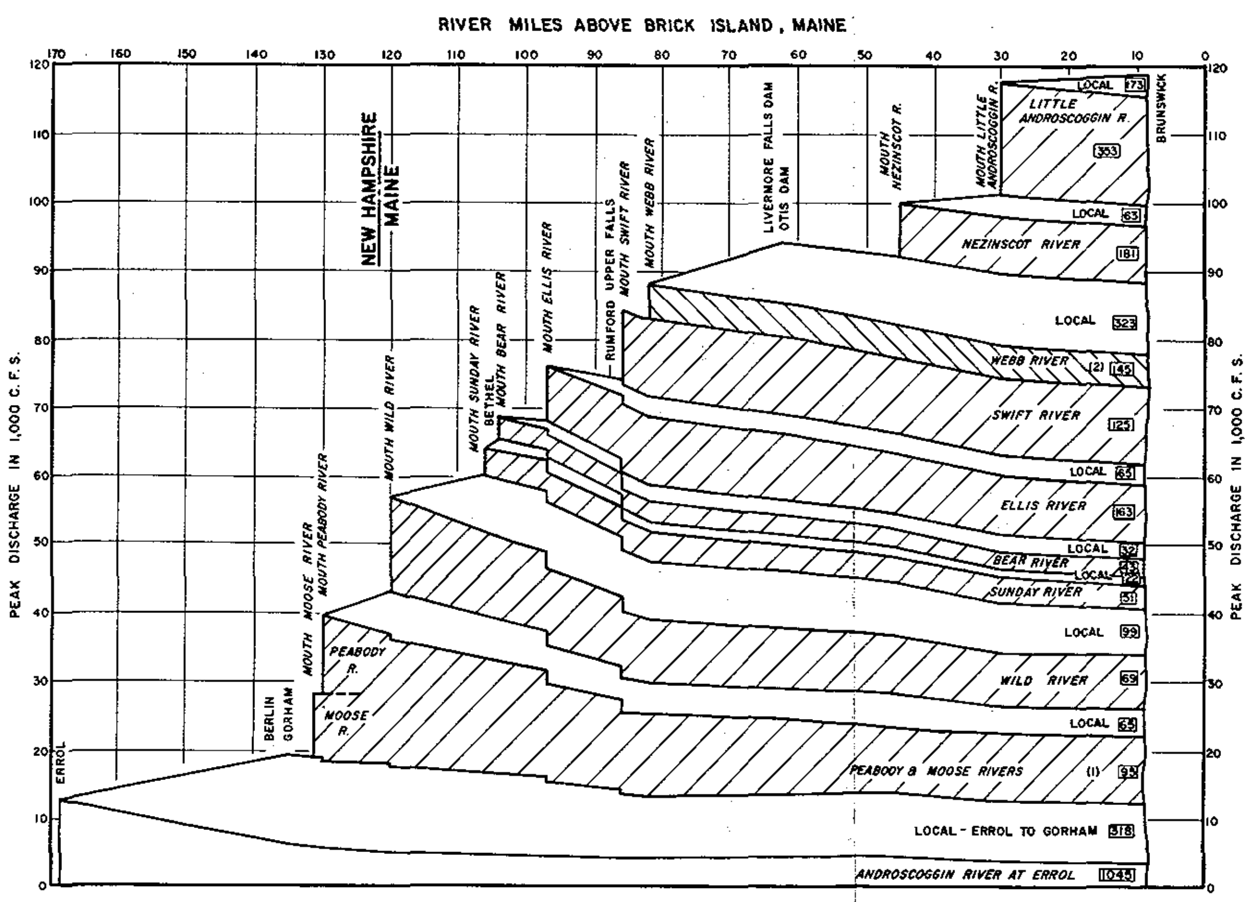
NOTES:

(1) Includes 24 sq. mi. of Local Area.

(2) Includes 13 sq. mi. of Local Area.

LEGEND

[363] Drainage Area in sq. mi.



PEAK DISCHARGE PROFILE AND TRIBUTARY CONTRIBUTIONS

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY / TR. BY M.W.B. / CK. BY

ANDROSCOGGIN RIVER FLOOD CONTROL

FLOOD OF MARCH 1936

ANDROSCOGGIN RIVER, MAINE & N.H.

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

APPROVED

DATE

CHIEF, PLANN. & RPTS. BRANCH

CHIEF ENGINEERING DIV.

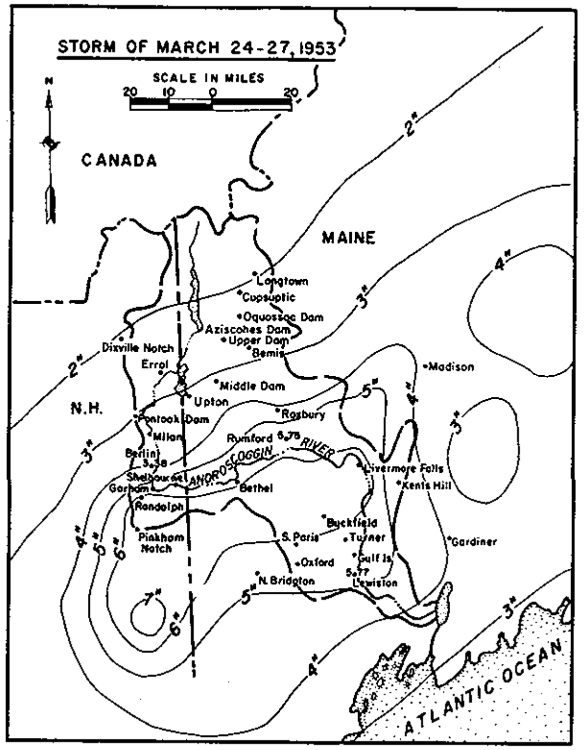
SCALE

SPEC. NO. CIV ENG.-19-016-

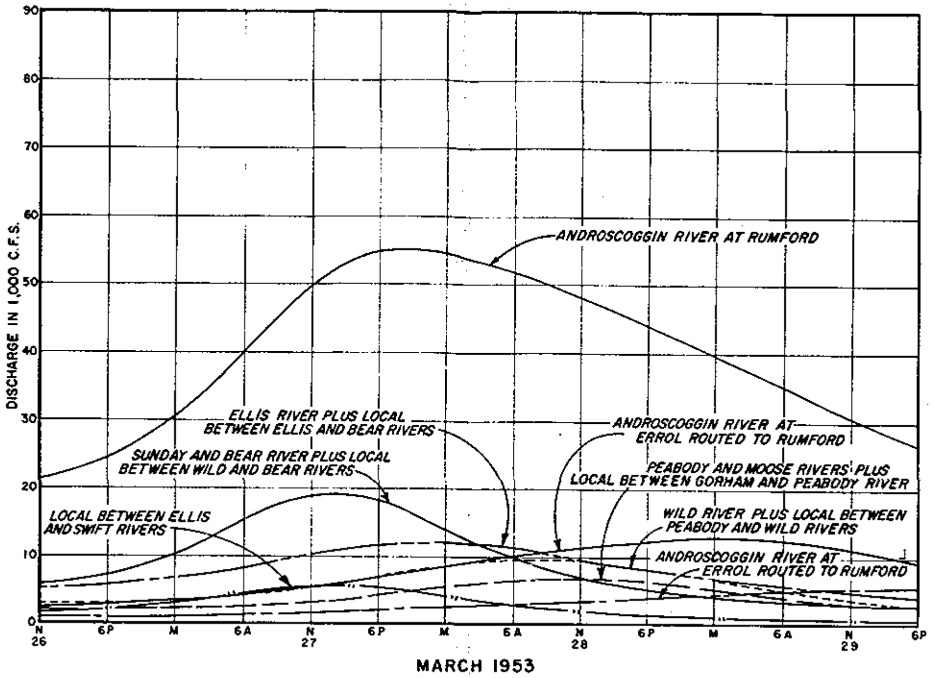
DRAWING NUMBER

SHEET

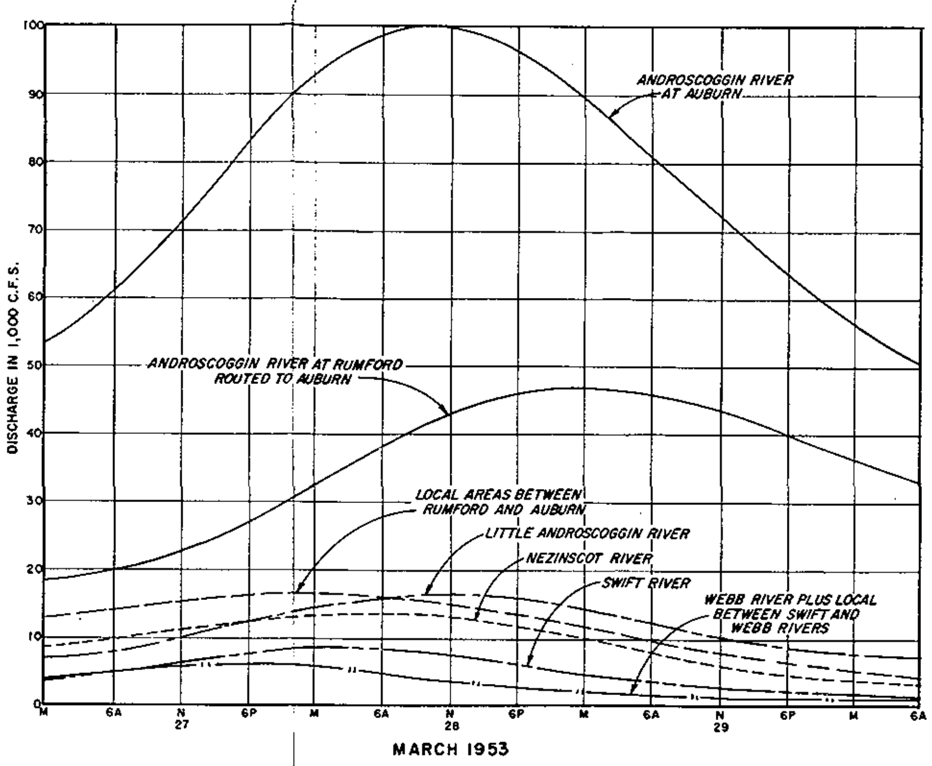
PLATE NO. B-20



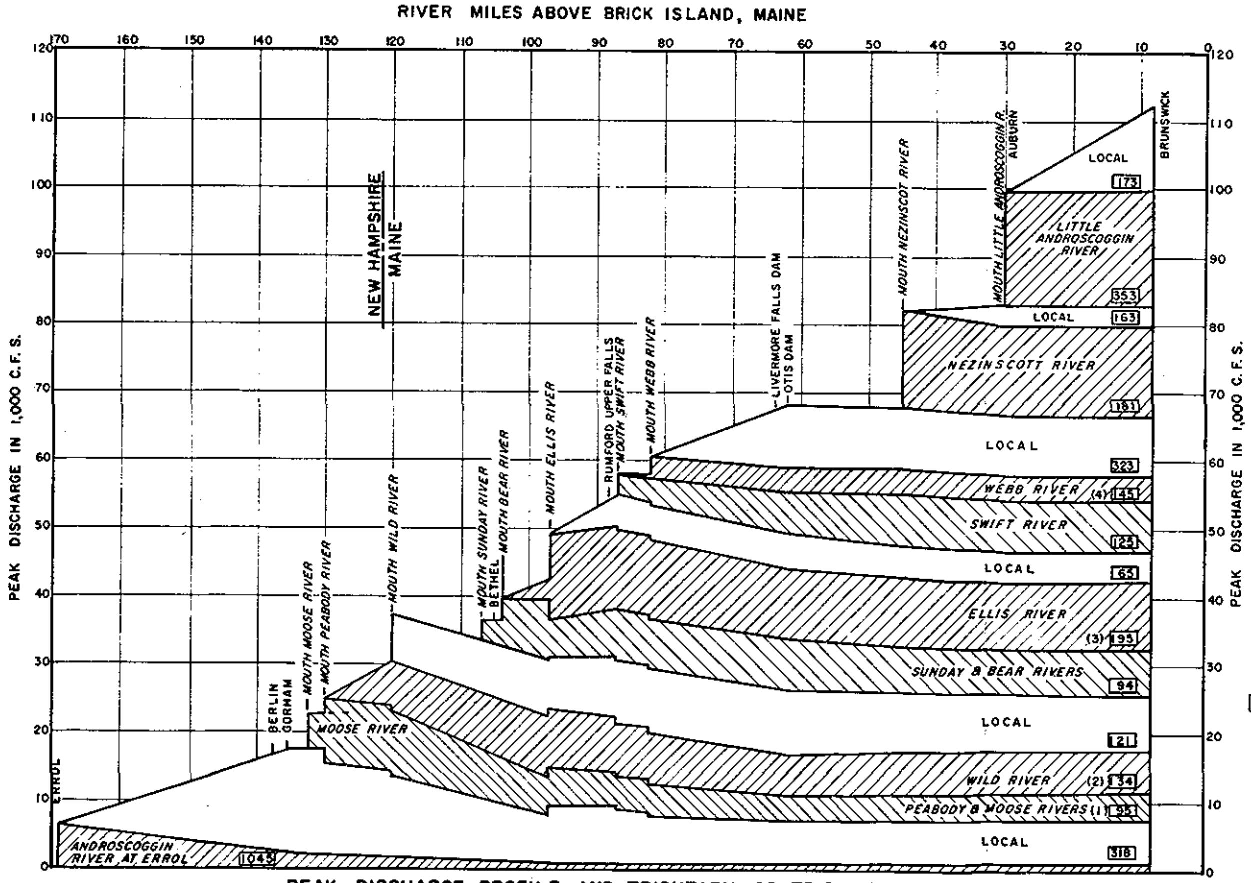
ISOHYETAL MAP



ANDROSCOGGIN RIVER AT RUMFORD



ANDROSCOGGIN RIVER AT AUBURN



PEAK DISCHARGE PROFILE AND TRIBUTARY CONTRIBUTION

LEGEND

1363 DRAINAGE AREA IN SQUARE MILES

NOTES:

(1) Includes 24 Square Miles of Local Area.
(2) Includes 65 Square Miles of Local Area.
(3) Includes 32 Square Miles of Local Area
(4) Includes 13 Square Miles of Local Area

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY G.H.D. | CK. BY

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANNING & RPTS. BRANCH

ANDROSCOGGIN RIVER FLOOD CONTROL

FLOOD OF MARCH 1953

ANDROSCOGGIN RIVER, MAINE & N.H.

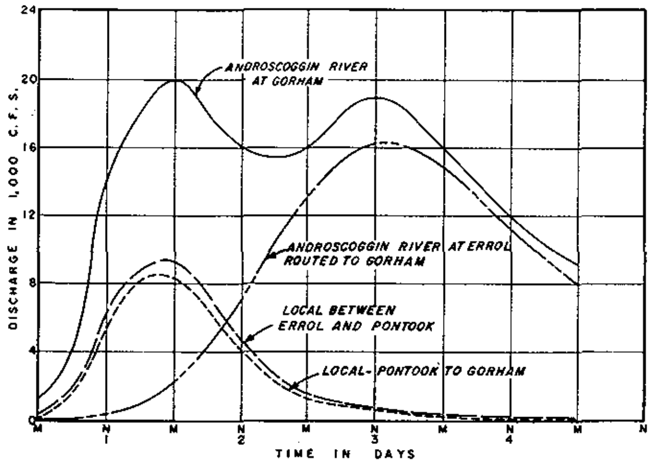
APPROVED DATE

CHIEF ENGINEERING DIV.

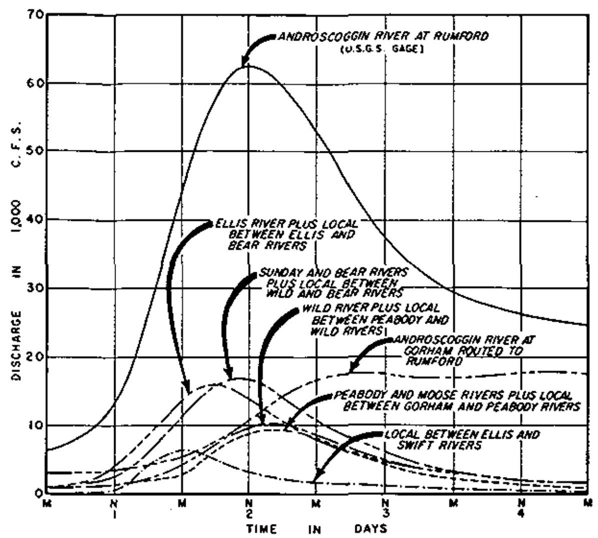
SCALE | SPEC. NO CIV ENG.-15-016-

DRAWING NUMBER

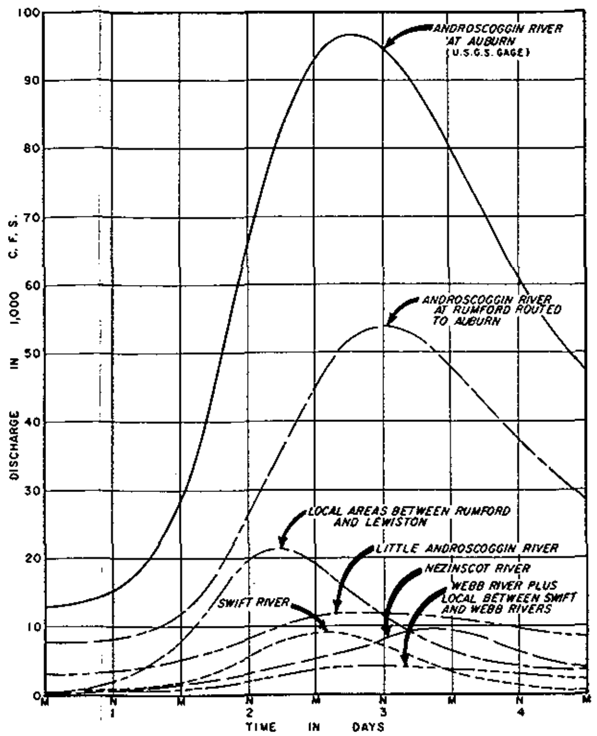
SHEET



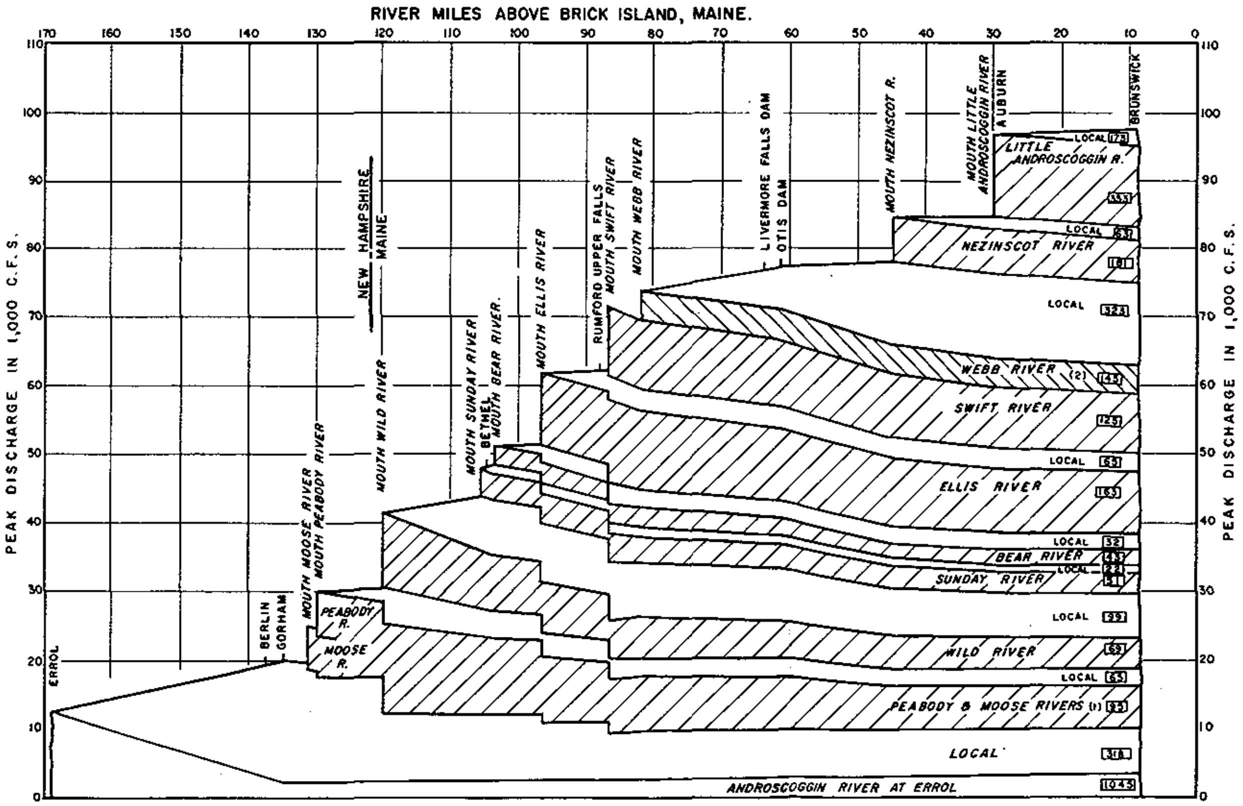
ANDROSCOGGIN RIVER AT GORHAM



ANDROSCOGGIN RIVER AT RUMFORD



ANDROSCOGGIN RIVER AT AUBURN



PEAK DISCHARGE PROFILE & TRIBUTARY CONTRIBUTIONS

LEGEND

[1363] DRAINAGE AREA IN SQUARE MILES

NOTES:

(1) Includes 24 Square Miles of Local Area.
(2) Includes 13 Square Miles of Local Area.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY GHO. | CK. BY

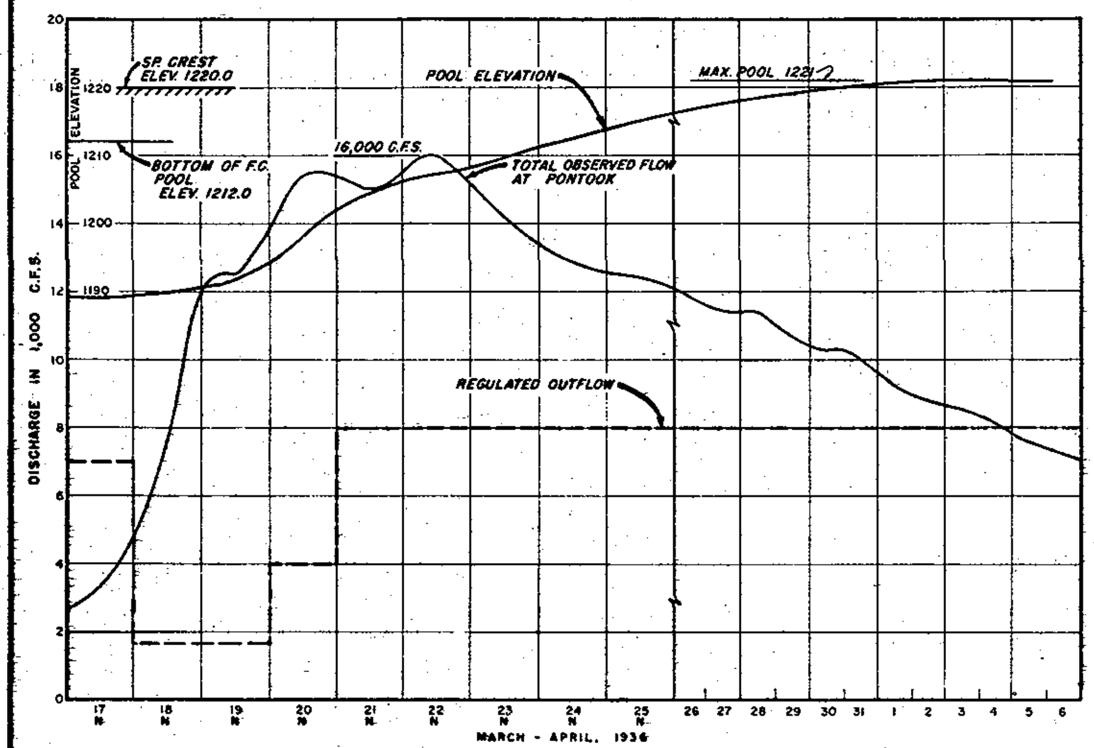
ANDROSCOGGIN RIVER FLOOD CONTROL

TYPICAL TRIBUTARY CONTRIBUTION FLOOD

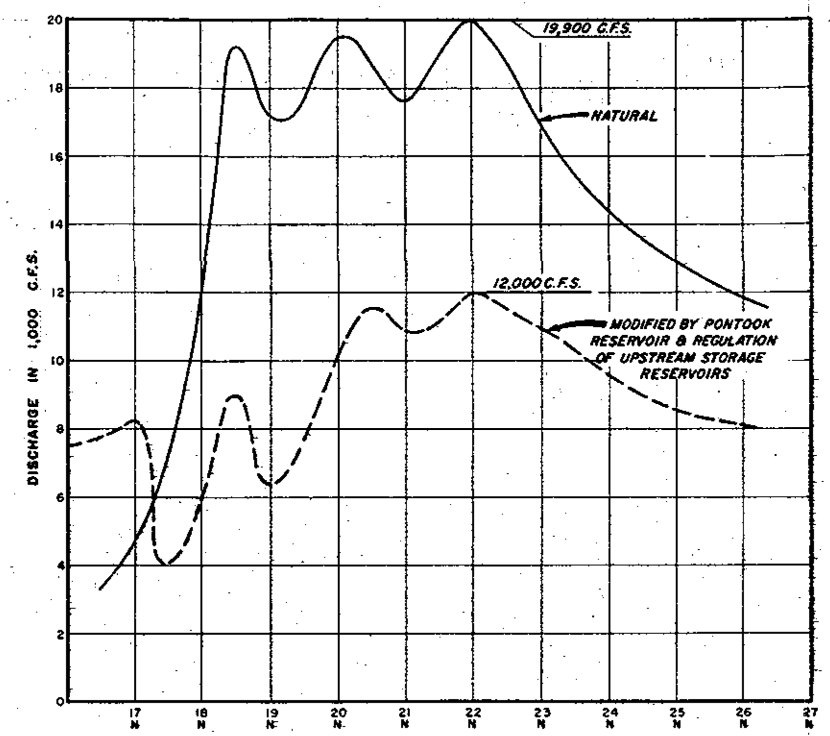
ANDROSCOGGIN RIVER, MAINE & N.H.

PROJECT ENGINEER | CHIEF, SECTION | SUBMITTED BY | APPROVED | DATE | CHIEF, PLANNING & RPTS. BRANCH | CHIEF ENGINEERING DIV.

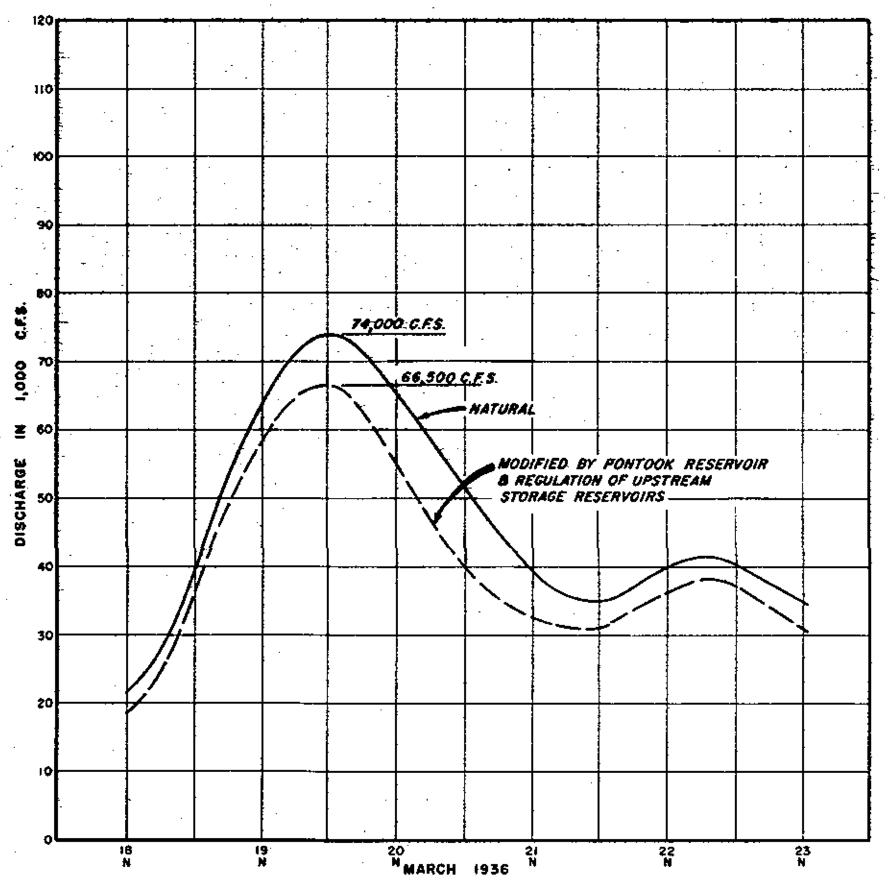
SCALE | SPEC. NO. CIV. ENG.-19-016- | DRAWING NUMBER | SHEET



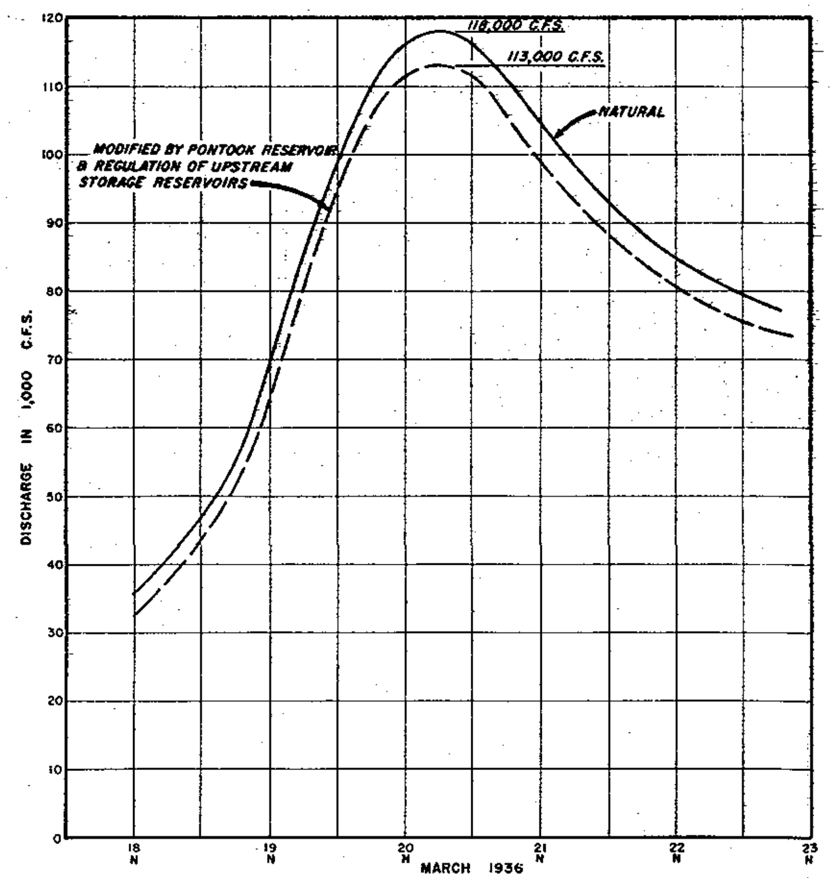
REGULATION AT PONTOOK RESERVOIR



ANDROSCOGGIN RIVER AT BERLIN, N.H.
(BASED ON U.S.G.S. GAGE NEAR GORHAM, N.H.)



ANDROSCOGGIN RIVER AT RUMFORD, ME.



ANDROSCOGGIN RIVER AT AUBURN, ME.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY M.S. | CK. BY

PROJECT ENGINEER

CHIEF, H & H. SECTION

SUBMITTED BY

CHIEF, PLANNING & RPTS. BRANCH

APPROVED:

CHIEF ENGINEERING DIV.

ANDROSCOGGIN RIVER FLOOD CONTROL

RESERVOIR REGULATION
MARCH 1936 FLOOD

ANDROSCOGGIN RIVER, MAINE & N.H.

APPROVED | DATE

COL., C.E. DEPUTY DIVISION ENGINEER

SCALE | SPEC. NO. CIV. ENG.-19-016-

DRAWING NUMBER

SHEET

APPENDIX C

ECONOMIC DEVELOPMENT

APPENDIX C

ECONOMIC DEVELOPMENT

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APPENDIX C

ECONOMIC DEVELOPMENT

1. MAINE

Maine, the largest of the New England states, with an area approximately as large as all the other New England states combined, has less than 10 percent of the region's population. With 51.3 percent of its population classified as urban (1960 Census), the state has the lowest per capita income in New England, 28.2 percent below the regional average and 19 percent below the national per capita (1962 data).

The Androscoggin Basin and the tributary area thereto is economically the most advanced area in the state. With over 41 percent of the state's population residing on only 13 percent of the state's land, the area accounts for 32 percent of the 2,500 concerns listed in the "Buyers Guide and Directory of Maine Manufacturers", published by the Maine Department of Economic Development (1962). Per capita income for the tributary area is 15 percent higher than for the state as a whole or just under the national average.

Androscoggin County which straddles the lower reaches of the river from Livermore Falls almost to tidewater, a distance of 60 miles, or roughly one half of the total stream in Maine, is the second most densely settled county in the state with 181 inhabitants per square mile (1960 Census). The Census designates 82 percent of the population as urban. With the exception of a 7-mile length of river between the lower end of Androscoggin County and tidewater and a 5-mile stretch of the river between Livermore Falls and Riley which cuts across a corner of Franklin County, the remainder of the river in Maine lies in Oxford County.

The two counties together, with a population of 13.5 percent of the entire state, accounted for 19 percent of the value of manufacture added for Maine in 1962. The industry producing this "value added" is concentrated in the Androscoggin River valley. If value added for the plants along the 5-mile stretch of river in Franklin County and the plants along the river between the lower Androscoggin County Line and tidewater is included, the river basin accounts for almost a quarter of Maine's manufacturing production, dollar-wise.

Plate 1 shows "Value Added by Manufacturing" for the state, for Androscoggin County, for Oxford County, and for the two counties combined. The decline in Androscoggin County between 1947 and 1954 is accounted for by the continuing decline of the textile industry, once a valley mainstay. Since 1957 the industry in the county has become stabilized and in the last four years has started to increase although it has not kept pace with the state as a whole.

In Retail Trade and Selected Services, the pattern for the State and for the river valley counties have following the same trend as for Value of Manufacture added. The State has shown an overall growth in each of the indices over the past 30 years with a leveling off in the rate of growth in the past 10 years. For the river valley counties there has been an overall growth in both indices in the 21-year period ending in 1960 for which data are available but in the last 6 years of that period the growth in retail trade was small while that in Selected Services was at a rate which was only a third of that for the state as a whole.

Population-wise, the valley has been relatively stable. The tributary area showed a growth of 5.4 percent in the decade 1950-1960. This compares with a state growth of 6.1 percent and a New England Regional growth of 12.8 percent for the same period. In the river valley proper, the growth was slightly over 2 percent with most of it concentrated in the area between Livermore Falls and tidewater. This growth accounted for all the growth in the two counties involved; in fact, overall, the population of Oxford and Androscoggin Counties has declined in the past 20 years.

The future of the river valley can be expected to follow past trends. Paper making, the largest portion of the manufacturing sector of the present economy of the basin will play an even larger role in the future. Announced expenditures for enlarging present plant and constructing new plant in the valley will exceed $60 million in 1964.

The increase in paper making is part of a state-wide trend. With 86 percent of Maine's area in forest and an abundance of water in most parts of the state, the raw materials for paper are readily available. A study by the U. S. Forest Service forecasts the following increases in the use of forest products in Maine.

Item	1962 Production (1,000 tons)	2000 Forecast Production (1,000 tons)
Wood Pulp	1626	3180
Paper & Paperboard	1831	3570

A constantly improving network of good roads is available to bring the forest products to the plants. In addition, a good rail network also furnishes such service. Two of the state's railroads, the Bangor and Aroostook and the Maine Central, are adding a fleet of 368 cars which are specially designed for pulp wood. The Maine Central, which is buying 200 of the cars, serves the entire Androscoggin valley in Maine.

The state's overall economic development over the project life is expected to improve over the present time and to approach the National level. An overall growth factor of 1 percent annually in the economy is projected. This represents a composite figure based on the expected growth in Value of Manufacture Added, Retail Trade, Selected Services, per capita income, and population.

For the Androscoggin River valley, the present state of development compared to the state as a whole indicates an economic growth rate somewhat less than the state as a whole even though the valley's propsects are good. Based on current trends, a composite growth rate of 0.75 percent annually in the overall economy is projected over the next 50 years with a leveling trend thereafter.

2. NEW HAMPSHIRE

The economy of the river valley in New Hampshire is almost wholly geared to one paper products company in Berlin. The company's business is stable and its supplies of raw materials ample. Because of the one plant economy, little change in this portion of the valley seems likely and little growth is expected.

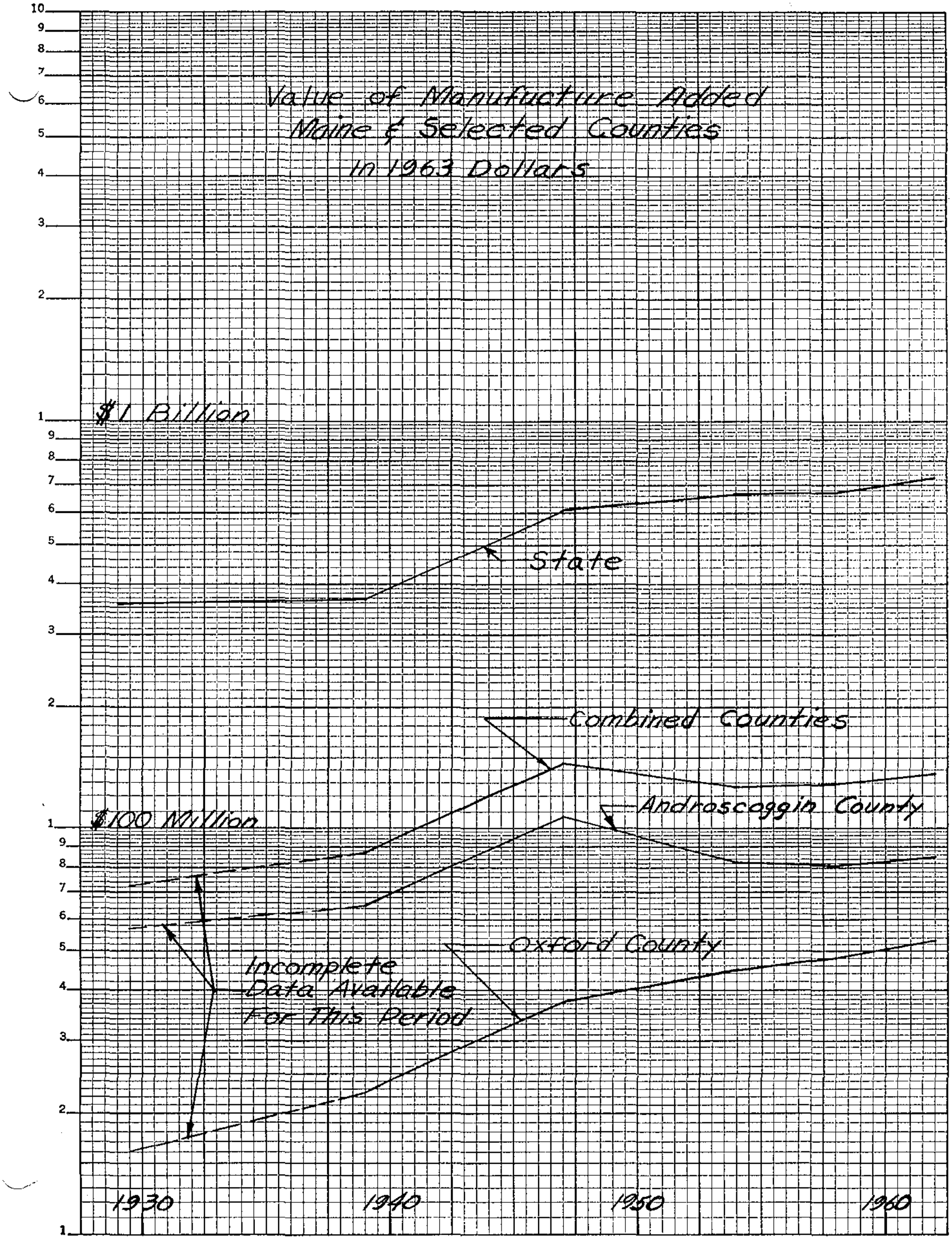
Value of Manufacture Added
Maine & Selected Counties
In 1963 Dollars
$1 Billion
$100 Million
State
Combined Counties
Androscoggin County
Oxford County
Incomplete Data Available For This Period
1930
1940
1950
1960
10
9
8
7
6
5
4
3
2
1

PLATE C-1

APPENDIX D

FLOOD LOSSES AND BENEFITS

APPENDIX D

FLOOD LOSSES AND BENEFITS

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APPENDIX D

FLOOD LOSSES AND BENEFITS

1. DAMAGE SURVEYS

A detailed damage survey was made in the main flood area of the Androscoggin River following the record flood of March 1936. Later surveys were conducted in 1952 and 1961 to obtain more detailed flood damage information in the river basin and to determine trends of development in the watershed. The surveys consisted of door-to-door interviews, and inspections of the various residential, commercial, rural, and industrial properties in the flooded areas. Information obtained included the extent of areas flooded, description of property, the nature and amount of damages, depths of flooding, high water references, and relationships between the March 1936 flood and other flood stages.

Damage estimates and depths of flooding were generally furnished by property owners and tenants, but investigators prepared alternative estimates when in their judgment, based on property examination, estimates of owners or tenants were unrealistic or unreliable. The investigation also made estimates when information was not available from owners or tenants. Where several properties of similar type were subject to the same depth of flooding, sampling methods were used. The review surveys were concerned principally with changes in use of previously surveyed properties, changes in business activities in the larger industrial plants covered in the original surveys and properties new in the flood area since the original surveys.

Sufficient data were obtained to derive loss estimates for (1) the March 1936 flood stage, (2) a stage 3 feet higher, and (3) intermediate stages where marked increases in damage occurred. The stage at which damage begins, referenced to the March 1936 flood stage, was also determined.

2. LOSS CLASSIFICATION

Flood loss information was recorded by type of loss and location. The types recorded include urban (residential, commercial and public), industrial, highway, rural and utilities.

Primary losses were evaluated, including (1) physical losses, such as damage to structures, machinery, equipment and stock and cost of cleanup and repairs, and (2) non-physical losses such as unrecoverable losses of business and wages, increased cost of operation, and the cost of temporary facilities.

Physical losses and a large part of the related non-physical losses were determined by direct inspection of flooded properties and evaluation of the losses by either the property owners or field investigators or both. The non-physical portions of the primary losses were often difficult to estimate on the basis of available information. When this difficulty existed, the non-physical losses were estimated by utilizing determined relationships between physical and non-physical losses for similar properties in the survey and other areas.

No evaluation was made of intangible losses including items such as possible loss of life, hazards to health, and detrimental effects on national security.

3. EXPERIENCED LOSSES

Following the disastrous flood of 1936, a survey of damages was made by field investigators of the Corps of Engineers. The survey disclosed that this flood caused total experienced damages amounting to $4,392,000, of which 96% was in Maine and four percent in New Hampshire. About 40 percent of the experienced loss was to industrial properties. Paper, pulp, and textile mills at Brunswick, Topsham, Lisbon Falls, Lewiston, Livermore Falls, Peru, and Rumford, Maine, and at Berlin, New Hampshire, which are major elements in the economy of the basin, were seriously affected. Urban losses of about $850,000 were experienced, with the major part of this loss being concentrated in the residential and commercial sections of Lewiston, Auburn, and Mexico, Maine. Highways in the basin sustained damages in excess of $700,000 and railroad damages amounted to $450,000. These damages included the loss of bridges which in some cases, have been rebuilt at higher elevations. Public utility properties, principally hydroelectric installations of the Central Maine Power Company, suffered damages amounting to $190,000 with attendant plant shutdown for up to seven weeks. Agricultural losses of $285,000 were experienced, with farms in Lisbon, Canton, Dixfield, Hanover and Bethel, Maine sustaining the major portion of this loss.

The flood of March 1953, the third highest at Rumford since 1892, caused losses totalling $2,230,000 in the entire river basin. Flood damages were experienced throughout the entire length of the main river from Berlin, New Hampshire to Brunswick, Maine, and along three of the principal tributaries, the Dead River in New Hampshire and the Swift and Little Androscoggin Rivers in Maine. Flood waters inundated a great many roads causing highway damages in excess of $150,000 and preventing motor transportation throughout a major portion of the basin for the greatest part of four days. Damages were sustained by industrial properties along the main river of Rumford, Peru, Livermore Falls, Lewiston, Auburn, Lisbon, Topsham, and Brunswick, Maine, and on the Little Androscoggin River at Mechanic Falls. The dam of the Pejepscot Paper Company at Lisbon Falls, Maine was breached. Replacement costs were estimated at $100,000. The Dead River overflowed streets in the business section of Berlin, New Hampshire, causing damages to a number of stores. The Swift River overflowed the main street of Mexico, Maine necessitating the evacuation of some 100 families and closing of the main commercial section of the town. Several railroad washouts occurred along the Androscoggin River in the Canton-Peru area, below Rumford; large areas of agricultural lands were flooded between Gilbertville and Bethel, Maine, and stream banks were eroded at numerous locations throughout the basin.

4. RECURRING LOSSES

Stage-damage and stage-discharge relationships were developed to reflect the magnitude of recurring losses at varying stages of flooding above and below the reference floods in the studied areas. The recurring losses used in development of the stage-damage relationships reflect economic and physical conditions in the areas at the present time.

The recurring loss from a 1936 flood on the main stem of the Androscoggin River from the Sawmill Dam in Berlin to below Brunswick is estimated at $12,457,000. Recurring losses by type are listed in Table D-1.

Twenty industrial firms employing over 9,000 persons are located along the river and would sustain substantial damage in the event of a recurrence of the 1936 flood. The industrial activities of these plants produce a diversified line of products including textiles at Lewiston, boots and shoes at Auburn, pulp and paper at Rumford and pulp, paper, and allied products in Berlin.

A summary of total recurring damages listed by damage centers is shown in Table D-2.

TABLE D-1

RECURRING LOSSES BY TYPE

1936 FLOOD
(1964 Price Level)

Type	Recurring Loss
Industrial	$ 8,057,000
Urban (Commercial, Residential & Public)	2,442,000
Highway	996,000
Railroad	336,000
Utilities	565,000
Rural (includes agricultural)	61,000
	$12,457,000

TABLE D-2

RECURRING LOSSES IN DAMAGE AREAS

1936 FLOOD
(1964 Price Level)

Area	Recurring Loss
Brunswick - Topsham	$ 2,951,000
Lewiston - Auburn	2,510,000
Livermore Falls	1,313,000
Rumford - Mexico	4,168,000
Shelburne, N.H.	219,000
Gorham - Berlin, N.H.	1,296,000
	$12,457,000

D-375

5. ANNUAL LOSSES

Estimated recurring losses along the river were converted to average annual losses by correlating stage-damage, stage-discharge and discharge-frequency data to derive damage-frequency relationships in accordance with standard Corps of Engineers practices. Plates D-1, D-2 and D-3 show the procedure used in converting recurring stage-damage data to annual losses and benefits. Average annual losses by major damage centers are listed in Table D-3.

TABLE D-3

PRESENT AVERAGE ANNUAL LOSSES

(1964 Price Level)

Brunswick - Topsham, Me.	$ 160,800
Lewiston - Auburn, Me.	87,600
Livermore Falls, Me.	93,600
Rumford - Mexico, Me.	188,000
Shelburne, N.H.	3,400
Gorham - Berlin, N.H.	137,600
	$ 671,000

6. FUTURE ANNUAL LOSSES

Flood losses in the Maine portion of the basin can be expected to increase at least as fast as the overall economic growth rate for the area. As discussed in Appendix C, Economic Development, the overall economy in the basin is expected to grow at a rate of 0.75 percent annually for the next 50 years and then remain stable for the following 50-year period. The total growth of 37.5 percent in 50 years was converted to an average annual equivalent value over the 100-year project life by compound interest methods using an interest rate of 3-1/8 percent. The annual equivalent value so derived amounts to 18.6 percent. Average annual losses adjusted for the expected growth amount to $750,000 at 1964 price levels.

7. BENEFITS

a. Tangible Flood Damage Prevention Benefits.

Construction of the Pontook project will reduce flood flows along the entire length of the Androscoggin River from Berlin to tidewater and provide substantial protection to presently flood prone properties. In a recurrence of the record flood of 1936, under today's conditions, the reservoir would prevent $3.5 million in losses.

Present average annual flood damage prevention benefits have been derived as the difference in annual losses along the river under present conditions and those that would remain after reduction in flood flows by the reservoir. Average annual benefits so derived for the Pontook project are $190,000.

b. Future Benefits.

When the growth in the Maine portion of the basin over the next 50 years is considered, the benefits at the end of the 50-year period will have grown to $217,600. Taken as an average annual equivalent value over a 100-year project life, the benefits to growth amount to $14,000. Total benefits over the life of the project, adjusted for growth, are therefore $204,000.

c. Redevelopment Benefits.

Pontook Dam is to be constructed in a portion of New Hampshire, Coos County, which has been named a Redevelopment Area by the Area Redevelopment Administration under Section 5b(6) of P. L. 87-27. The construction will put to work residents of the area who are unemployed or under-employed and the wages thereto are considered a benefit under current policy. Division records for Civil Works construction over the past 9 years indicate that for the type of construction involved the labor costs average 27% of total contract cost. Based on the present estimated construction cost of Pontook, the total labor cost would be $9,300,000. After discounting for the number of people who will be hired locally (70%) and for the number so hired who will be unemployed or under-employed (75%), a total labor benefit of $5,000,000 is creditable to the project. As this is to be dispersed over a six-year period, the expenditures for years 2 through 6 are discounted by present worth factors at 3-1/8% interest rate. The discounted value of the benefit is $4,500,000. Amortized over the 100-year project life, the annual benefit amounts to $147,400, rounded to $148,000.

d. Intangible Benefits.

In addition to tangible benefits resulting from project construction, important intangible benefits will be realized. Among these are prevention of possible loss of life, prevention of disease caused by flooding of polluted water, and the stabilizing effect on community life in the valley by the reduction in the flood threat.

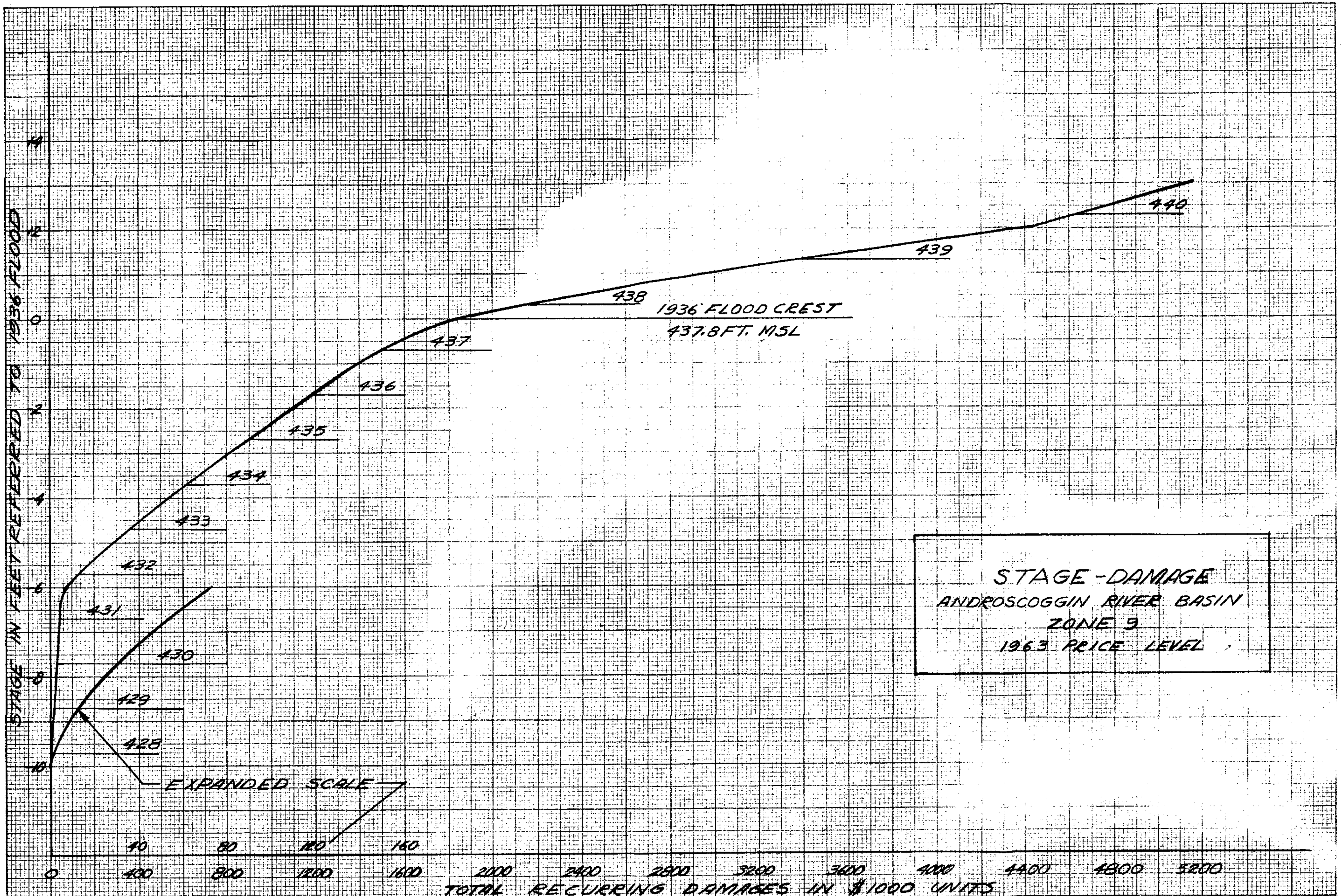
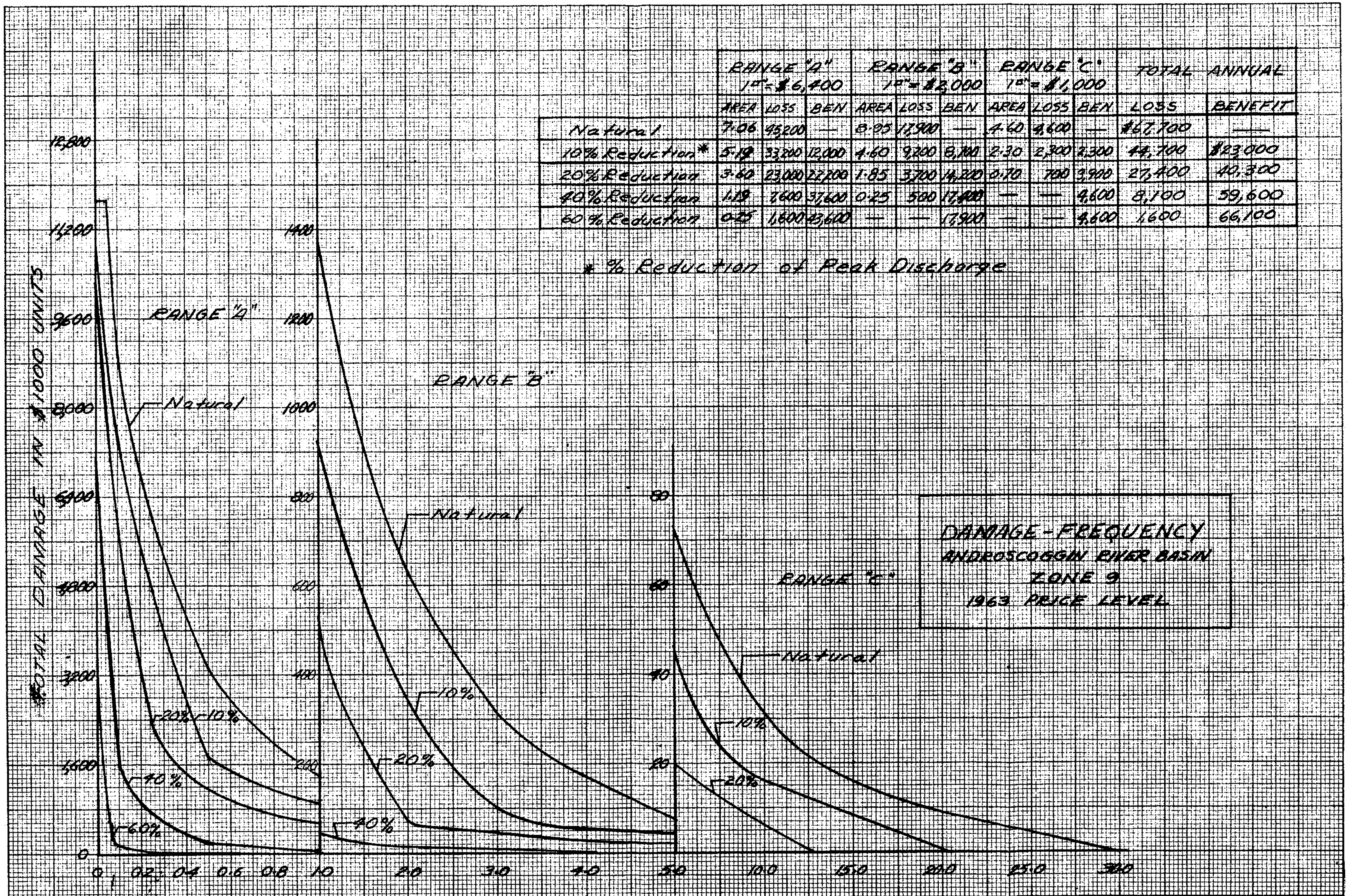

STAGE - DAMAGE
ANDROSCOGGIN RIVER BASIN
ZONE 3
1963 PRICE LEVEL
1936 FLOOD CREST
437.8 FT. MSL
EXPANDED SCALE
STAGE IN FEET REFERRED TO 1936 FLOOD
TOTAL RECURRING DAMAGES IN $1000 UNITS
428
429
430
431
432
433
434
435
436
437
438
439
440
14
12
0
2
4
6
8
10
40
80
120
160
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
4400
4800
5200

PLATE NO. D-1



	RANGE "A" 1" = $6,400			RANGE "B" 1" = $2,000			RANGE "C" 1" = $1,000			TOTAL ANNUAL	
	AREA	LOSS	BEN	AREA	LOSS	BEN	AREA	LOSS	BEN	LOSS	BENEFIT
Natural	7.06	45,200	—	8.95	17,900	—	4.60	4,600	—	$67,700	—
10% Reduction*	5.19	33,200	12,000	4.60	9,200	8,700	2.30	2,300	2,300	44,700	$23,000
20% Reduction	3.60	23,000	22,200	1.85	3,700	14,200	0.70	700	3,900	27,400	40,300
40% Reduction	1.19	7,600	37,600	0.25	500	17,400	—	—	4,600	8,100	59,600
60% Reduction	0.25	1,600	43,600	—	—	17,900	—	—	4,600	1,600	66,100

* % Reduction of Peak Discharge

PLATE NO. D-2

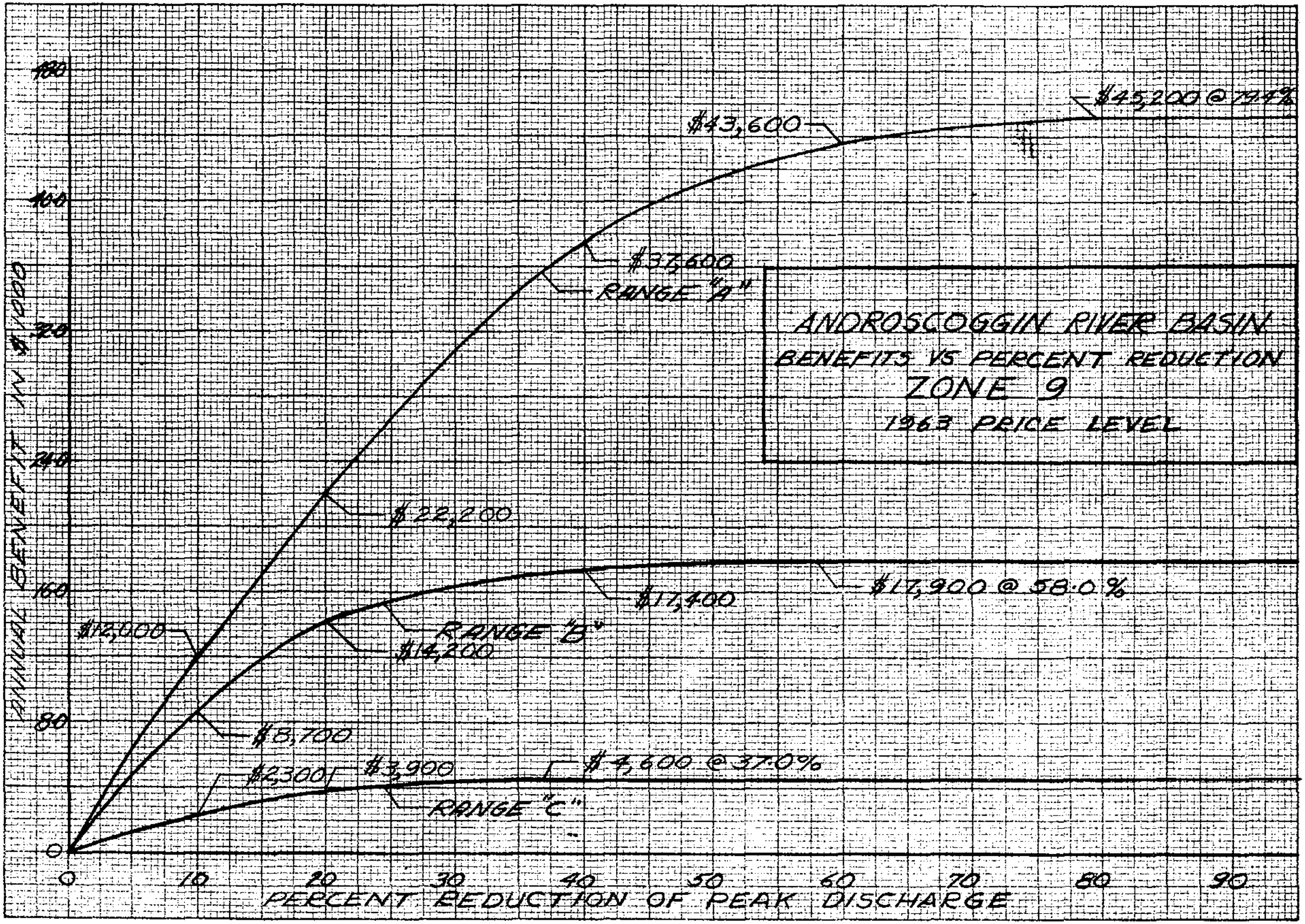

ANDROSCOGGIN RIVER BASIN
BENEFITS VS PERCENT REDUCTION
ZONE 9
1963 PRICE LEVEL
ANNUAL BENEFIT IN $1000
PERCENT REDUCTION OF PEAK DISCHARGE
0
10
20
30
40
50
60
70
80
90
80
$45,200 @ 79.4%
$43,600
$37,600
RANGE "A"
$22,200
$12,000
$8,700
$17,900 @ 58.0%
$17,400
RANGE "B"
$14,200
$2,300
$3,900
$4,600 @ 37.0%
RANGE "C"

PLATE NO. D-3

APPENDIX E

PONTOOK PROJECT

APPENDIX E

PONTOOK PROJECT

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TABLES (cont'd.)

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PERTINENT DATA

PONTOOK DAM & RESERVOIR

ANDROSCOGGIN RIVER BASIN

MAIN DAM

Drainage Area, sq. mi.	1,215 gross 170 net below Errol Dam	
Elevations, mean sea level datum		
Top of dam	1239	
Full flood control pool	1220	
Full power pool	1212	
Min. power pool	1182	
Streambed at dam	1124	
Average tailwater	1118	
Reservoir Areas	**acres**	**sq. mi.**
Full flood control pool	7,470	11.7
Full power pool	6,500	10.2
Min. power pool	2,950	4.6
Reservoir Storage, acre-feet		
Flood control	58,000	
Useable power	141,000	
Dead	39,000	
Critical flow period	7/40 - 6/42	
Maximum gross head, feet	94	
Average net head, feet	82	
Net head during critical low flow period, feet	82	
Minimum net head, feet	62	

Flows, c.f.s.

Minimum dependable	1,675
Useable dependable	1,572
Max. discharge at rated capacity	23,000

Power Production

Installed capacity, kw	135,000
Average annual energy, kwh	107,000,000
Minimum December energy, kwh	5,301,000
Capacity factor, average annual	9.05%
Minimum December load factor	5.38%

Embankments

	Dam	Dike
Length - feet	2,000	1,120
Volume - cu. yds.	1,200,000	100,000

Spillway Crest

Elevation, msl	1220
Length, feet	485

Flood Control Gates

Number	5
Size, each - feet	10 x 10

Penstock

Number	2
Diameter - feet	32

Penstock Intake Gates

Number	6
Size, each - feet	13 x 30

Road Relocation - miles	13.5
Road Raised to Higher Level - miles	2.5
Recreational Development	
Main reservoir shoreline - miles	35
Estimated annual visitation, initial	110,000
" " " , ultimate	404,000

REREGULATING DAM

Installed capacity, kw	3,000
Average annual energy, kwh	18,000,000
Top of dam elev., msl	1141
Maximum height, feet	57
Spillway crest elev. - msl	1118
Total capacity - acre feet	9,300
Useable capacity - ac. ft. (pondage)	4,100
Useable dependable flow, cfs	1,637

REAL ESTATE REQUIREMENTS

Main dam and reservoir, land - acres	10,000
Recreation, land - acres	3,400
Fish and wildlife, land - acres	8,800
Reregulating dam, land - acres	800
Main dam, improvements - units	57
Reregulating dam, improvements - units	16

APPENDIX E

PONTOOK PROJECT

1. MAIN DAM AND RESERVOIR

a. Description.

(1) Dam. The dam site is located on the Androscoggin River in the town of Dummer, New Hampshire. The dam, with a top elevation of 1,239 feet above mean sea level, will be of rock-fill construction, approximately 2,000 feet long and a maximum height of 115 feet above the river bed. A side-channel spillway with an ogee weir 485 feet long at elevation 1,220 will be constructed in the east abutment. The flood control regulating structure will be located at the junction of the dam embankment and the spillway and will be provided with five 10' x 10' gates with sill at elevation 1,182. An intake structure containing six 13' x 30' and one 6½' x 32' gates will be located at the upstream toe of the dam. Two 32' diameter steel-lined, concrete penstocks will lead from the intake structure to the powerhouse at the downstream toe of the dam, and one 7' x 6' concrete conduit for sluicing logs will be provided as the outlet for the smaller gate. A rock-fill dike, with a top elevation of 1,239, approximately 1,120 feet long and a maximum height of 39 feet will be constructed to close a saddle adjacent to the east abutment of the dam. A general plan of the dam and dike is shown on Plate 3 of the main report.

(2) Reservoir. The reservoir at spillway crest elevation of 1,220 will be about 16 miles long, have a surface area of 7,470 acres, and a gross capacity of 238,000 acre-feet. The lake, created by the maximum power pool at elevation 1,212, will have an area of 6,500 acres and extend up the river about 15 miles. The reservoir will contain a storage capacity of 58,000 acre-feet for flood control purposes between elevation 1,220 and 1,212, and 141,000 acre-feet for joint power, flood control, and recreation purposes between elevation 1,212 and 1,182. The storage reserved solely for flood control is equivalent to 6.4 inches of runoff from the net drainage area of 170 square miles - the drainage area between Errol Dam and the project site. With a power pool elevation of 1,212 in the reservoir and a tailwater elevation of 1,118 at the powerhouse a total gross head of 94 feet will be developed. Two 67,500 kilowatt generating units - a total of 135,000 kilowatts - will be installed in the powerhouse. The plant will produce 107,000,000 kilowatt-hours

annually at an average annual capacity factor of 9.05 percent. The study of hydroelectric power for this project is included in Appendix F.

b. Recreation. Land and water areas in and adjacent to the reservoir will be allocated to recreational activities and fish and wildlife conservation. Initial facilities contemplated include swimming, picnicking, camping, boating, hunting, fishing, and other water-oriented uses. A total of 12,200 acres of land will be acquired specifically for general recreation and for fish and wildlife mitigation purposes. A report prepared by the U. S. Fish and Wildlife Service, detailing the need for and the requirements for fish and wildlife mitigation measures, is included in Appendix H to this report. General recreation is discussed in Appendix G.

2. REREGULATING DAM AND POOL

a. Description.

(1) Dam. The damsite is located about 3.5 miles downstream from the main dam on the Androscoggin River in the town of Milan, New Hampshire. The dam will be of rolled earth-fill, approximately 2,500 feet long, have a maximum height of 57 feet above the river bed, and a top elevation of 1,141. A fixed crest spillway, 155 feet long at elevation 1,118, and gated outlet works with a powerhouse on the downstream face of the structure will be constructed in the west abutment of the dam. Flows through the horizontal Kaplan turbine in the powerhouse will be controlled by a 22' x 15' gate. A 15' x 7' gate is provided for sluicing logs, trash, and ice through the dam. Two 9' x 4' gates will regulate discharges from the pool when the power station is not operating. A general plan of the reregulating dam is shown on Plate 4 of the main report.

(2) Pool. The pool at spillway crest elevation 1,118 will extend up the river to the main dam, have a surface area of 690 acres, and a gross capacity of 9,300 acre-feet. A storage capacity of 4,100 acre-feet will be utilized for reregulating and power purposes between elevation 1,118 and 1,112. To meet the uniform flow requirements established for the upper Androscoggin River by interests having riparian rights along the waterway, facilities will be provided in the dam to regulate the flow from the pool to a minimum release of 1,637 cubic feet per second with a drawdown of 6 feet from elevation 1,118, with discharge through the powerhouse or the gates in the outlet works.

Gate discharges will be adjusted as required for the sluicing of logs, ice, or debris through the 15' x 7' gate in the outlet works. For the generation of hydroelectric power, a gross head of 18 feet will be developed between pool elevation 1,118 and tailwater elevation of 1,100 at the powerhouse. Generating facilities for 3,000 kilowatts, in a single horizontal unit producing an average of 18,000,000 kilowatt-hours annually at a capacity factor of 68.5 percent, will be installed in the power house.

b. Recreation. No improvements for the development of recreational facilities will be provided for the pool or shore area in the reregulating reservoir since the surface of the pool will fluctuate from the sudden release of turbine discharges from the main dam powerhouse. A 100-foot strip of land on each bank of the Androscoggin River from the reregulating dam downstream to the vicinity of the Berlin Municipal Airport (approximately 5 miles) will be needed to provide public access to the river for sports fishery. About 100 acres of land will be involved.

3. GEOLOGY AND SOILS

a. Geology of the Area.

(1) Main Dam and Dike. The site of the main Pontook dam is approximately one mile downstream from an existing timber crib logging dam, an area in which private interests investigated other dam alignments in some detail in 1929, and in 1946 through 1949. The latter investigations were made for hydroelectric power developments utilizing the saddle between Holt and Veezey Hills for a canal leading to the penstocks and powerhouse located about two miles downstream. In 1953, the New England Division, in studies for the New England-New York Inter-Agency Committee report, investigated this area for power development and made two test borings to check foundation conditions. In 1964, the Public Service Company of New Hampshire applied to the Federal Power Commission for a preliminary permit to restudy the site.

The course of the river through the damsite is post-glacial, flowing on a pavement of boulders derived from erosion of thick glacial till deposits. The main abutments are formed by the till slopes of Bickford Hill on the right or west bank and Holt Hill on the left or east bank of the river. The left bank is formed by the face of a sand terrace which extends for a width about 200 feet to its contact with the till slope. Bedrock is exposed high on Bickford Hill and in the high saddle to be diked east of Holt Hill. It is not exposed at low elevations in this stretch of river except at a location about one mile downstream where the rock surface has been uncovered by deep erosion in the right bank which deflects the river abruptly eastward.

(2) Reregulating Dam. The site is located approximately 3.5 miles downstream from the main dam. The right abutment is a rock-controlled slope with outcropping above height of the dam. The main portion of the embankment will be constructed on the wide flood plain of the Androscoggin River with a far left abutment tie to sandy terrace deposits.

b. Geological Investigations.

(1) Main Dam and Dike. Geological reconnaissance was first made of the selected damsite in October of 1961 and was the basis for distribution of preliminary subsurface explorations shown in layout and recorded on Plate E-1. None of the topographic mapping nor subsurface explorations made for prior investigations in this stretch of river are applicable to this site. The topography used was taken from U. S. Geological Quadrangle for Milan, New Hampshire adjusted to a surveyed profile within the damsite limits.

The dike is located in a high saddle between Holt and Veezy Hills previously considered for a spillway location. Two borings (FD-4 and FD-5) were made for this purpose. These explorations and applicable others previously made by private interests in the saddle vicinity are shown on plan and recorded on Plate E-2.

(2) Reregulating Dam. A profile was surveyed on the dam alignment and three test borings were made with concentration of borings near the river section and right bank where structures are proposed. The general location of these explorations and their records in relation to the surveyed profile are shown on Plate E-2.

c. Foundation Conditions.

(1) Main Dam. Dense, impermeable glacial till is available at nominal depths for cut-off under the embankment. The subsurface conditions shown in geologic section on Plate E-1 are believed generally applicable throughout the damsite limits. The relatively pervious strata encountered at depth within the till and yielding to produce artesian flows in two of the borings probably do not have any great continuity. However, preliminary embankment design provides for a system of relief wells at the downstream toe of the embankment.

Bedrock does not outcrop in the damsite area, but from a deep preglacial channel under the right abutment the rock surface rises with the left abutment to within about 20 feet of ground surface at height of dam. Power and spillway structures will be located on or in rock on the left abutment. The bedrock cores, although schistose in structure, are generally fine-grained and relatively massive. No loss of drill water occurred in coring operations and recoveries were generally in the 90-100 percent range with sections of core recovered in lengths up to 5 feet. The dip of schist foliation is 50 to 60 degrees and strike as observed in outcrops remote from the damsite is indicated to be northeasterly about 70 degrees. This orientation of rock structure at about a right angle to the river, coupled with an apparent sound and massive condition, indicates at this stage of investigation no major problems of seepage control, foundation bearing, or structure excavations.

(2) Dike. The saddle dike (39 feet in height) is located about a mile remote from the left or east abutment of the dam. As shown in profile on Plate E-2, relatively impervious materials of a till-like nature are expected to occur at accessible depths for cut-off to control seepages through the foundation.

(3) Reregulating Dam. Foundation conditions are depicted in log-profile on Plate E-2. Although preliminary explorations have been concentrated at structure locations near the river section and right abutments, the overburden, consisting of loose interbedded outwash sediments, is expected to persist throughout the low embankment section. Structures have been fitted to a steeply dipping rock surface as developed from borings on the center-line which, for purpose of this report, is assumed to apply throughout. The rock is basically a quartz-mica schist which, from recovered cores, appears to present no problems as to foundations or excavations.

d. Construction Materials. Impervious materials in the form of glacial till and overlying materials of a random nature will be available from required excavations and from borrow areas as necessary which can be established conveniently near embankment locations. Pervious materials in the form of sands and gravelly sands occur in abundance in terraces which have been worked on the left bank of the river about 4 miles downstream from the damsite. About 4 miles upstream from the damsite, and bordering the reservoir, there are two large depositional projections into the west side of the valley consisting of gravelly sands with gravel strata, one of which has been worked for road construction. However, since gravelly materials are relatively scarce in this region, it is expected that these latter deposits would be largely worked out for the reconstruction of State Highway Route No. 16 considered in this report. Other potential undeveloped sources of sands and gravels occur in and along the Ammonoosuc River in West Milan and vicinity at a haul distance of 5 to 10 miles. Requirements for gravel bedding and aggregates for concrete may be met from commercial sources. The nearest source is operating in terrace deposits at Gorham, New Hampshire located down river at a haul distance of about 16 miles. Materials from this source have previously been tested and approved for use in concrete at other planned civil works projects in northeastern Vermont and northwestern New Hampshire. However, the estimated overall concrete quantity of about 150,000 cubic yards requires consideration of near site production. Fine aggregates would be available from extensive deposits of gravelly sands in terrace remnants located about 4 miles downstream from the main dam. Production of suitable coarse aggregates may require quarrying in igneous or volcanic rocks that occur within 4 miles of the main dam.

Materials for rock slope protection and rock-fills will be provided from required rock excavations. The rock is structurally a schist but its relatively massive, fine-grained quartzitic nature should provide fragmentation and durability very suitable for slope protection.

4. REAL ESTATE

a. Character. Land in the project area includes woodland, very little farmland, swamp areas, and a mowed field utilized as an emergency landing field. The project area also includes a privately-owned, single lane, steel girder bridge, a breached wood crib dam, seasonal homes, camps and cottages, several small dwellings, one overnight cabin establishment, one large lodge, and a gas station.

b. Taking. A plan of the guide taking lines established for the project are shown on Plate 2 of the main report with use of land as follows:

(1) Main Dam and Reservoir. About 10,000 acres of land will be acquired for the full flood control pool at spillway crest elevation 1,220 plus a 300-foot strip along the shore of the pool, the damsite and work areas, and the relocation of Route 16. An additional 3,400 acres, as shown on the plan, will be acquired for recreation purposes and for the granting of easement rights to logging interests for access to the river. To compensate for loss of winter deer yards and damage to

fisheries, waterfowl, and fur-bearers, a total of 8,700 acres will be acquired in stream and swamp areas adjacent to the reservoir but outsideof the flood pool and along Chickwolnepy Stream.

(2) Reregulating Dam and Pool. Approximately 800 acres will be acquired for the pool area at elevation 1,121 (spillway crest plus 3 feet), the damsite, and appurtenant structures, including the relocation of a secondary road on the east bank of the river. An additional 100 acres will be acquired along the banks of the river for sports fishery access including land for two vehicle parking areas. The strips will be 100 feet wide and extend from the reregulating dam to the vicinity of the Berlin Municipal Airport.

c. Mineral Rights. A current field inspection revealed that no mining of minerals is apparent in the required areas.

d. Water Rights. The Brown Company, the Union Water Company, and the Public Service Company of New Hampshire own water rights in the project area for storage of water for downstream power production and process water. An estimated $10,000 is included for water rights and the breached dam in the reservoir area.

e. Gravel Pit. There is one commercially operated gravel pit within the reservoir area off Route 16 in the town of Dummer.

f. Severance Damage. The land to be acquired in fee in the main dam project area will remove all of the small ownerships, leaving only the three large timber land ownerships, Brown Company, Pingree, and Coe. Severance damage for this area is estimated to be nominal. For the reregulating dam area, the severance damage is estimated to be $7,000.

g. Resettlement.

(1) Main Dam. There will be approximately 60 units eligible for resettlement at an estimated $675 each, for a total resettlement cost of $40,000.

(2) Reregulating Dam. Three units at $1,075 and 13 units at $675 are eligible for resettlement for a total cost estimated at $12,000.

h. Valuation. The valuations of property are based on the Market Data approach, and on a study of recent sales.

(1) Main Dam.

(a) Improvements.

3	Residences (including outbuildings)	$ 21,000
48	Summer Cottages and Camps	93,000
1	Farm (including outbuildings)	5,000
3	Commercial	34,000
1	Boat House	300
1	Barn	700
57	Improvements - Total Estimated Cost	$154,000

(b) Land.

Improved lots	100 acres	@ $700	$ 70,000
Gravel pits	10 acres	@ 200	2,000
Emergency landing field	10 acres	@ 120	1,200
Tillage	200 acres	@ 50	10,000
Woodland	17,880 acres	@ 60	1,072,800
Swamp	3,000 acres	@ 10	30,000
Roads and River	1,000 acres	@ 0	--
Total Estimated Cost	22,200 acres		$1,186,000

(2) Reregulating Dam.

(a) Improvements.

12	Residences	$ 50,000
4	Farms	30,000
16	Improvements - Total Estimated Cost	$ 80,000

(b) Land.

Improved lots	20 acres	@ $1,250	$ 25,000
Tillage and pasture	500 acres	@ 50	25,000
Woodland	150 acres	@ 60	9,000
River	130 acres	@ 0	--
Total Estimated Cost	800 acres		$ 59,000

i. Acquisition Costs. It is estimated that there will be 75 tracts for the main dam and 25 tracts for the reregulating dam involved in the project. Experience in other reservoir areas has indicated that administrative costs of acquisition average $1,000 per tract including mapping, survey, title evidence, appraisal, negotiation, closing, condemnation, and administrative overhead. Total costs are estimated at $75,000 for the main dam and $25,000 for the reregulating dam.

j. Summary of Real Estate Costs. A summary of the estimated costs of real estate for the Pontook project is given in Table E-1. Contingencies are estimated at 20 percent.

TABLE E-1

SUMMARY OF REAL ESTATE COSTS

	Thousand Dollars				
	Joint Use	Power(1)	Fish and Wildlife(2)	Recreation	Total
Land	$536	$59	$480	$170	$1,245
Improvements	154	80	0	0	234
Water rights	10	0	0	0	10
Severance	0	7	0	0	7
Resettlement	40	12	0	0	52
Contingencies	220	32	70	30	352
Sub Total	960	190	550	200	1,900
Acquisition	75	25	0	0	100
Totals	1,035	215	550	200	2,000

(1) Specific costs for reregulating dam.
(2) Specific costs for mitigation of fish and wildlife losses.

k. Salvage Value. Due to uncertainties on resale value and costs of disposition in the future, no salvage value was assigned to project lands at the end of the economic life of the project.

5. RELOCATIONS

a. Cemeteries. There are no cemeteries within the project land-taking limits.

b. Roads. Route 16 and secondary roads that would be affected and the proposed relocations are indicated on Plates 2 and 3 in the main report. Approximately $13\frac{1}{2}$ miles of Route 16 northerly from the main dam would be relocated and about $2\frac{1}{2}$ miles would be raised. An access road would be provided between relocated Route 16 and an existing, privately-owned, single-lane, steel girder bridge that spans the Androscoggin River. The bridge, requiring reconstruction to above full flood pool elevation, is utilized for logging purposes. About 3 miles of a secondary road located on the east bank of the river will be relocated outside of the reregulating dam and pool area. The cost of relocated Route 16 is based on a paved width of 24 feet with 5-foot shoulders.

c. Utilities. Utilities requiring relocation consist of electric service and telephone lines along existing roads to be relocated and a 115 kv transmission line within the limits of the full flood pool area.

6. COST ESTIMATE

a. Basis of Estimate. Topographic maps of the U. S. Geological Survey and U. S. Army Map Service were supplemented by a field survey of the centerline profile of the dam and dike areas. Foundation conditions were determined by borings and field reconnaissance. Quantities of the principal construction items were estimated on the basis of preliminary design plans which would provide safe structures for the given conditions and hydraulic criteria. The estimate on clearing is based on complete clearing within the maximum power pool, for structures, and for access. A four-year construction period was assumed for purposes of determining the Federal investment.

b. Unit Prices. Unit prices are based on average bid prices for similar work in the same region, adjusted to 1964 price levels. Costs of electrical, mechanical, and hydraulic equipment was obtained from published prices and consultations with manufacturers.

c. Contingencies, Engineering, and Overhead. To cover contingencies, construction and relocation costs have been increased by 20 percent. The cost of engineering and design has been based on knowledge of the site and experience on similar projects. The cost of supervision and administration has been taken as 8 percent of construction costs.

d. Annual Charges. Annual charges are based on an annual interest rate of 3-1/8 percent with the cost of the project amortized over an estimated 100-year useful economic life. An allowance is made for maintenance, operation, and major replacement costs and for tax loss on lands transferred to Federal ownership. The cost for replacement of items estimated to have a life less than the life of the project is included in the item "Major Replacements".

e. Cost Estimate. A breakdown of costs of property and damages is given in paragraph 4 of this appendix and is summarized in Table E-1. A breakdown of the major construction items, together with their estimated cost, is given in Table E-2. Allocations of costs among project purposes are shown in Table E-3. Table E-4 illustrates the cost sharing for recreation under H. R. 9032 and under previous Corps policy.

TABLE E-2

FIRST COST - PONTOOK PROJECT
(1964 Price Level)

1. LANDS & DAMAGES (Itemized in Table E-1)	
Lands	$ 1,245,000
Improvements	234,000
Water rights	10,000
Severance	7,000
Resettlement	52,000
Contingencies	352,000
	$ 1,900,000
Acquisition	100,000
TOTAL - LANDS & DAMAGES	$ 2,000,000
2. RELOCATIONS	
a. Roads	
Relocation of Route 16	$ 2,850,000
Raise portions of existing Route 16	360,000
Contingencies	640,000
TOTAL - Roads	$ 3,850,000

2. RELOCATIONS (continued)

b. Utilities & Structures

Relocation of 115 KV transmission line and utility lines	$ 130,000
Relocation of Brown Co. logging bridge	470,000
Contingencies	120,000
TOTAL - Utilities & Structures	$ 720,000
Sub-total (a & b)	$4,570,000
Engineering & Design	290,000
Supervision & Administration	360,000
TOTAL - RELOCATIONS	$5,220,000

3. RESERVOIR CLEARING

6,000 ac. @ $375	$2,250,000
Contingencies	450,000
	$2,700,000
Engineering & Design	170,000
Supervision & Administration	210,000
TOTAL - RESERVOIR CLEARING	$3,080,000

4. DAM	Estimated Quantity	Unit	Unit Price	Estimated Amount
Site preparation	87	ac.	1,000	$ 87,000
Stream control	1	Job	L.S.	400,000
Earth exc. (common)	1,200,000	c.y.	0.50	600,000
Compacted gravel fill (borrow)	281,000	c.y.	2.20	618,200
Gravel bedding (borrow)	3,000	c.y.	3.40	10,200
Embankment, rolled	750,000	c.y.	0.20	150,000
Rock exc. (open cut)	780,000	c.y.	2.25	1,755,000
Rock placing				
Rock fill	640,000	c.y.	0.25	160,000
Rock filter (process and place)	70,000	c.y.	3.00	210,000
Rock slope protection	4,000	c.y.	0.60	2,400
Concrete, mass.	3,600	c.y.	37.00	133,200

TABLE E-2 (cont'd.)

4. DAM (continued)	Estimated Quantity	Unit	Unit Price	Estimated Amount
Concrete, reinf.	47,000	c.y.	65.00	$3,055,000
Power intake				
Superstructure	116,000	c.f.	0.75	87,000
Trash racks	1	Job	L.S.	350,000
Gates & hoists	1	Job	L.S.	1,032,000
125-ton crane	1	Job	L.S.	100,000
Log sluice intake				
Superstructure	15,000	c.f.	0.75	11,250
Gate & hoist	1	Job	L.S.	72,000
Log driving facilities	1	Job	L.S.	75,000
Flood control outlet				
Superstructure	17,000	c.f.	0.75	12,750
Gates & hoists	1	Job	L.S.	230,000
45-ton crane	1	Job	L.S.	25,000
Penstock - steel liner	1	Job	L.S.	1,343,000
Line drilling	1	Job	L.S.	11,000
Access roads & bridge	1	Job	L.S.	110,000
Relief wells	1	Job	L.S.	145,000
Contingencies				2,160,000
				$12,945,000
Engineering & Design				823,000
Supervision & Administration				1,022,000
TOTAL - DAM COST				14,790,000

5. FISH AND WILDLIFE FACILITIES

Parking areas	$ 66,000
Deer yards	50,000
Wildlife impoundment	49,000
	165,000
Engineering & Design	40,000
Supervision & Administration	45,000
TOTAL - FISH & WILDLIFE FACILITIES (Exclusive of lands - see Table E-1 included in item 1 of this table)	$ 250,000

TABLE E-2 (cont'd.)

6. POWER PLANT	Estimated Quantity	Unit	Unit Price	Estimated Amount
a. Main Dam Power Plant				
(1) Powerhouse				
Earth exc. (common)	1,150,000	c.y.	0.50	$ 575,000
Rock exc. (open cut)	136,000	c.y.	2.25	306,000
Rock slope protection	25,000	c.y.	0.60	15,000
Gravel bedding	18,000	c.y.	3.40	61,200
Compacted gravel backfill	36,000	c.y.	2.20	79,200
Reinf. concrete	8,600	c.y.	65.00	559,000
Mass conc. substructure	70,000	c.y.	47.00	3,290,000
Superstructure	1,440,000	c.f.	0.75	1,080,000
Scroll cases	2	each	303,000	606,000
Contingencies				1,318,600
				$ 7,890,000
Engineering & Design				500,000
Supervision & Administration				620,000
TOTAL - Powerhouse				$ 9,010,000
(2) Turbines & Generators				
Turbines	2	each	2,520,000	$ 5,040,000
Generators, 67,500 KVA	2	each	1,460,000	2,920,000
Installation	1	Job	L.S.	1,314,000
Step-up transformers and associated switchgear				800,000
Contingencies				826,000
				$10,900,000
Engineering & Design				190,000
Supervision & Administration				250,000
TOTAL - Turbines and Generators				$11,340,000
(3) Tailrace, Accessories & Misc. Equipment				
Earth exc. (common)	742,000	c.y.	0.50	$ 371,000
Rock slope protection	47,000	c.y.	0.60	28,200
Gravel bedding	37,000	c.y.	3.40	125,800
Powerhouse crane	2	each	170,000	340,000

TABLE E-2 (cont'd.)

6. POWER PLANT (cont'd.)	Estimated Quantity	Unit	Unit Price	Estimated Amount
Draft tube gates	4	each	280,000	$1,120,000
Draft tube gantry crane	1	Job	L.S.	350,000
Chain link fence	1	Job	L.S.	68,000
Misc. elec. equip.	1	Job	L.S.	405,000
Misc. power plant equip.	1	Job	L.S.	311,000
Contingencies				621,000
				$3,740,000
Engineering & Design				237,000
Supervision & Administration				293,000
TOTAL - Tailrace, Accessories & Misc. Equip. Cost				$4,270,000
TOTAL - Main Dam Power Plant (Item 6a)				$24,620,000

b. Reregulating Dam & Power Plant

(1) Dam and Powerhouse

Reservoir clearing	70	acre	500	$ 35,000
Site preparation	14	acre	1,000	14,000
Stream control	1	Job	L.S.	70,000
Earth exc. common	160,000	c.y.	0.50	80,000
Impervious borrow	280,000	c.y.	0.40	112,000
Gravel bedding (borrow)	70,000	c.y.	2.20	154,000
Rock excavation	76,000	c.y.	2.25	171,000
Embankment, rolled	320,000	c.y.	0.20	64,000
Rock placing	90,000	c.y.	0.60	54,000
Concrete, mass	19,800	c.y.	47.00	930,600
Concrete, reinf.	4,100	c.y.	65.00	266,500
Powerhouse superstructure	98,000	c.f.	1.00	98,000
Line drilling	3,000	s.f.	4.00	12,000
Road relocation	1	Job	L.S.	530,000
Utilities relocation	1	Job	L.S.	12,000
Contingencies				516,900
				$3,120,000
Engineering & Design				200,000
Supervision & Administration				250,000
TOTAL - Dam and Powerhouse				$3,570,000

TABLE E-2 (cont'd.)

6. POWER PLANT (cont'd.)	Estimated Quantity	Unit	Unit Price	Estimated Amount
(2) Turbine and Generator				
Turbine and generator	1	job	L.S.	$ 660,000
Contingencies				65,000
				$ 725,000
Engineering and Design				25,000
Supervision & Administration				30,000
TOTAL - Turbine and Generator				$ 780,000
(3) Accessories & Misc. Equip.				
Outlet gates	2	each	30,000	$ 60,000
Sluice gate	1	each	95,000	95,000
Powerhouse crane	1	job	L.S.	33,000
Powerhouse elevator	1	job	L.S.	25,000
Trash racks	1	job	L.S.	9,000
Head gates	2	each	50,000	100,000
Draft tube stoplogs	1	job	L.S.	13,000
Log boom	1	job	L.S.	20,000
Contingencies				75,000
				$ 430,000
Engineering and Design				28,000
Supervision & Administration				32,000
TOTAL - Accessories & Misc. Equip.				$ 490,000
Total - Reregulating Dam & Power Plant (Item 6b)				$4,840,000
TOTAL - POWER PLANT (Items 6a & 6b)				$29,460,000

7. RECREATION FACILITIES - Initial Development
(For details, see Appendix G)

Day use - park area	$ 414,750
Camping area	119,000
Boat launching & marina area	37,000
Administration & maintenance area	53,000
Water supply	71,000
Miscellaneous - Trails, landscaping, etc.	14,750

TABLE E-2 (cont'd.)

	Estimated Quantity	Unit	Unit Price	Estimated Amount
7. RECREATION FACILITIES (cont'd.)				
Contingencies				$ 140,500
				$ 850,000
Engineering & Design				80,000
Supervision & Administration				70,000
TOTAL - RECREATION FACILITIES				$1,000,000
8. BUILDINGS, GROUNDS & UTILITIES				
	1	Job	L.S.	$ 110,000
Contingencies				20,000
				$ 130,000
Engineering & Design				10,000
Supervision & Administration				10,000
TOTAL - BUILDINGS, GROUNDS & UTILITIES				$ 150,000
9. PERMANENT OPERATING EQUIPMENT				
	1	Job	L.S.	$ 29,000
Contingencies				6,000
				$ 35,000
Engineering & Design				7,000
Supervision & Administration				8,000
TOTAL - PERMANENT OPERATING EQUIPMENT				$ 50,000
TOTAL PROJECT FIRST COST				$56,000,000

NOTE: This estimate does not include preauthorization study costs of $50,000

TABLE E-3
PONTOOK PROJECT
ANNUAL CHARGES ALLOCATION
(in $1,000 at 1964 Price Level)

	MULTIPLE-PURPOSE PROJECT					ALTERNATIVE DUAL PURPOSE PROJECTS			ALTERNATIVE SINGLE PURPOSE PROJECTS		
	SPECIFIC COSTS			Joint Use Cost	TOTAL						
	F.C.	Power	Rec.			Power Rec.	F.C. Rec.	F.C. Power	F.C.	Power	Rec.
CONSTRUCTION PERIOD (Years)					(4)	(4)	(2)	(4)	(2)	(4)	(2)
INVESTMENT & ANNUAL CHARGES											
Construction Expenditure	0	37,700	1,200	17,100	56,000	51,600	19.000	54,800	7,100	50,400	17,900
Interest during construction (3-1/8%x$\frac{1}{2}$xYrs)	0	2,356	75	1,069	3,500	3,225	594	3,425	222	3,150	559
Present worth of future additions for rec.	0	0	405	0	405	405	405	0	0	0	405
Investment	0	40,056	1,680	18,169	59,905	55,230	19,999	58,225	7,322	53,550	18,864
Annual Charges											
Interest (3-1/8%)	0	1,252	52	568	1,872	1,726	625	1,820	229	1,673	590
Amortization (0.00151)	0	60	3	27	90	83	30	88	11	81	28
Operation & Maintenance	5	283	20	25	333	328	45	308	30	307	44
Major Replacements	0	43	32	18	93	87	44	61	2	56	41
Loss of Taxes on Land	0	0	5	33	38	37	36	33	7	32	35
TOTAL ANNUAL CHARGES	5	1,638	112	671	2,426	2,261	780	2,310	279	2,149	738

ALLOCATION OF ANNUAL CHARGES	F.C.	Power	Rec.	TOTAL
Benefits	204	3,594	289	4,087
Alternative Project	279	2,149	738	3,166
Benefits Limited by Alt. Cost	204	2,149	289	2,642
Separable Cost	165	1,646	116	1,927
Remaining Benefits	39	503	173	715
Allocation of Joint Use Costs	27	351	121	499
TOTAL ALLOCATION, ECONOMIC	192	1,997	237	2,426
ALLOCATION OF LOSS OF TAXES ON LAND				
Separable Costs	1	2	5	8
Allocation of Joint Use Costs	2	21	7	30
Total Allocations	3	23	12	38
ALLOCATION OF O & M				
Separable Costs	5	288	25	318
Allocated Joint Costs	1	10	4	15
Total Allocation	6	298	29	333
ALLOCATION OF MAJOR REPLACEMENTS				
Separable Costs	6	49	32	87
Allocation Joint Costs	0	4	2	6
Total Allocation	6	53	34	93
ALLOCATION OF INVESTMENT				
Annual Investment	177	1,623	162	1,962
Ratio of Annual Investment	9.021	82.722	8.257	100.000
Allocated Investment	5,404	49,555	4,946	59,905
ALLOCATION OF CONSTRUCTION EXPENDITURES				
Specific Investment	0	40,056	1,680	41,736
Investment in Joint Use Facilities	5,404	9,499	3,266	18,169
Interest during Construction	318	559	192	1,069
Const. Exp. in Joint Use Facilities	5,086	8,940	3,074	17,100
Percent Const. Expend. in Joint Use Facilities	29.743	52.281	17.976	100.000
Const. Exp. in Specific Facilities	0	37,700	1,200	38,900
TOTAL CONSTRUCTION EXPENDITURE	5,086	46,640	4,274	56,000
BENEFIT:COST RATIO	1.06	1.80	1.22	1.68

With ARA benefits of $148,000

$$B/C = \frac{4,235}{2,426} = 1.75$$

TABLE E-4

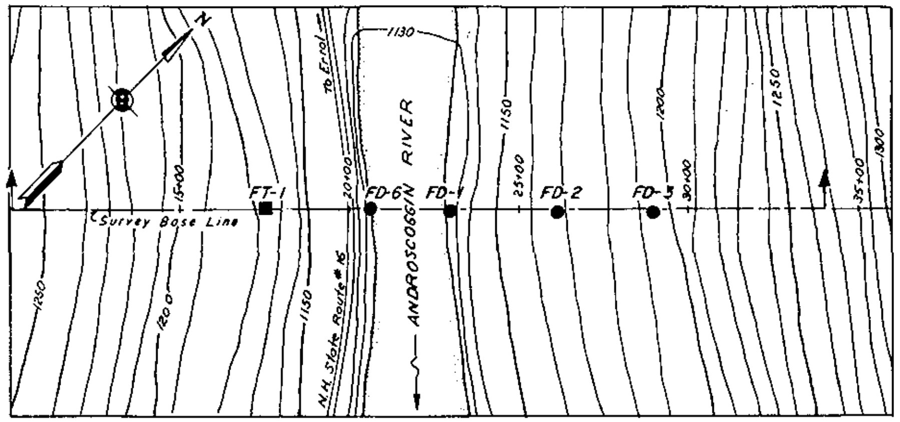
PONTOOK DAM AND RESERVOIR COST-SHARING FOR RECREATION

(Including Fish and Wildlife Enhancement)

1. Basic Data	
(From cost allocation study)	
a. Total costs	$56,000,000
b. Total specific costs	38,900,000
c. Total joint-use costs	17,100,000
d. Costs allocated to recreation	4,274,000
e. Separable costs, recreation	1,200,000
f. Joint costs, recreation (d-e)	3,074,000
g. Specific costs, recreation	1,200,000
h. Other costs, recreation (e-g)	0
2. Cost-Sharing Under HR 9032	
a. Federal	
(1) Specific costs (1g)	1,200,000
(2) Other costs (1h)	0
(3) Limit on other costs (25% x 1c)*	4,275,000
(4) Joint costs (1f)	3,074,000
(5) Limit on joint costs**	3,565,000
(6) Federal cost [(1) + smaller of (2) or (3) + smaller of (4) or (5)]	$ 4,274,000
b. Non-Federal	
(1) Excess of other costs [a(2)-a(3)]	None
(2) Excess of joint costs [a(4)-a(5)]	None
(3) Total non-Federal cost [b(1)+b(2)]	None
3. Cost-Sharing Under Previous Corps Policy	
a. Federal	
(1) Specific costs (1g)	$ 1,200,000
(2) Joint costs, recreation (1f)	3,074,000
(3) Limit on joint costs (25% x 1a)	14,000,000
(4) Other costs (1h)	0
(5) Federal cost [(1)+smaller of (2) or (3)+(4)]	$ 4,274,000
b. Non-Federal	
(1) Excess of joint costs [a(2)-a(3)]	None

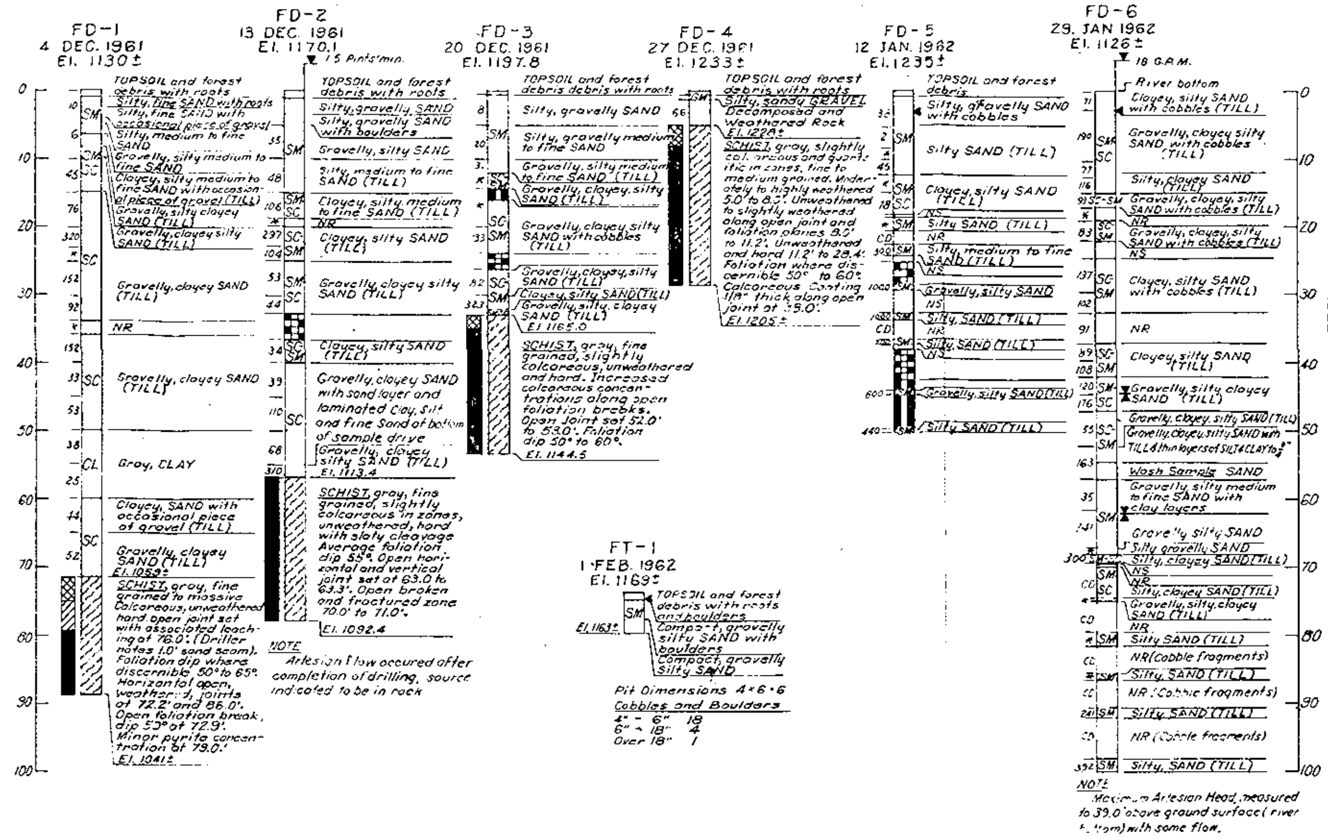
*Maximum = $5,000,000

**$2,500,000 + 15% x $7,100,000



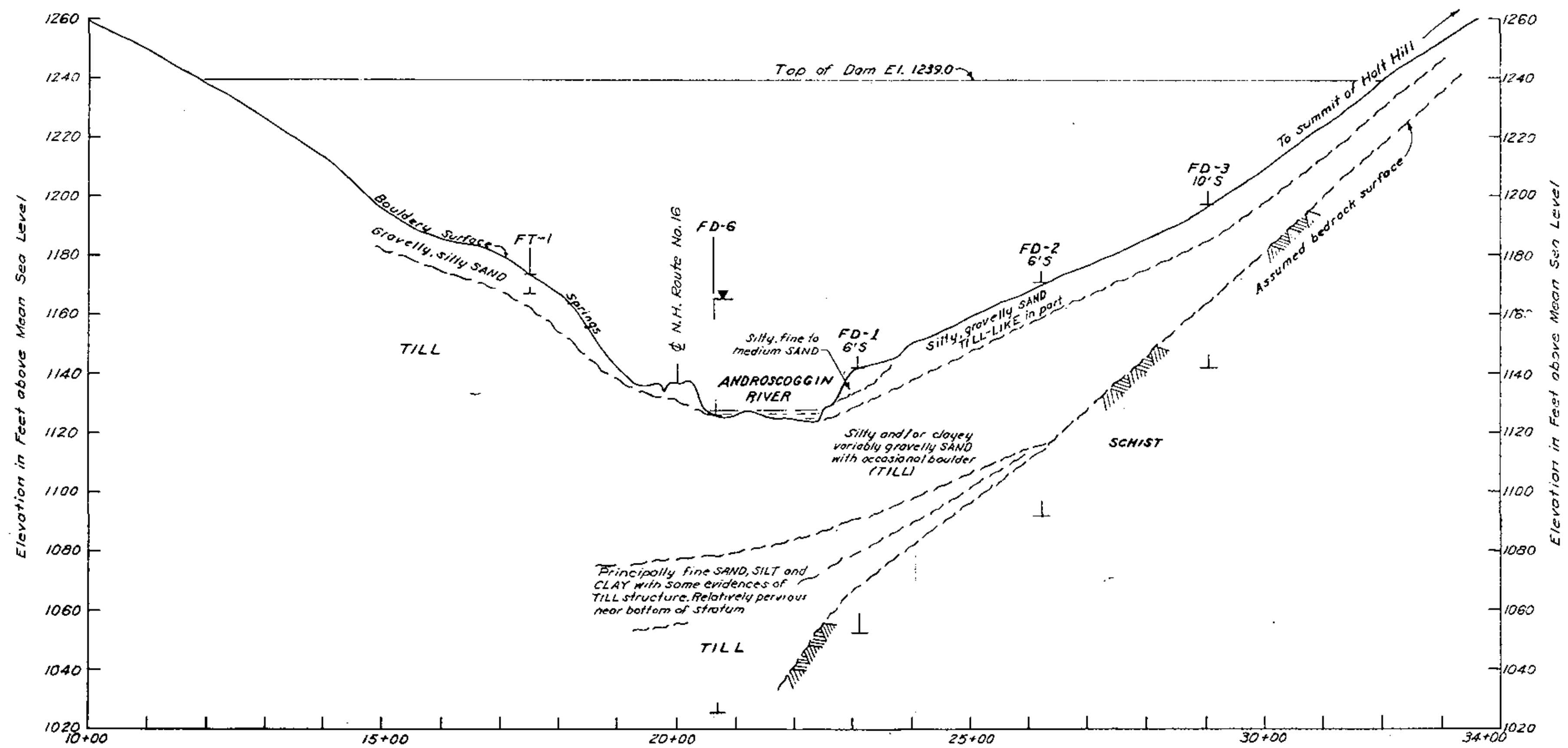
PLAN

SCALE 1" = 200'
(CONTOUR INTERVAL IS 10')



LEGEND FOR GRAPHIC LOGS

- FD — Foundation Test Boring
- FT — Foundation Test Pit
- 4 DEC. 1961 — Date exploration completed
- El. 1121± — Elevation of ground surface during time of exploration
- Artesian head
- Subsurface water level in boring at time of exploration.
- Artesian flow encountered
- SP — Group letter symbol according to Unified Soil Classification System.
- NR — No Recovery or unsatisfactory soils samples recovered
- NS — Not Sampled. Hole advanced by Core-drilling, blasting and/or wash boring due to operational difficulty.
- CD — Sampling in overburden by Core-drilled method
- 25 — Blows per foot of penetration considered most representative for each sample drive using a 350 pound hammer with a free fall of about 18" on a 1⅜" I.D. or 2" O.D.; 2" I.D. or 2½" O.D. and/or 2½" I.D. or 3" O.D. size sample spoon equipped with a beveled and sharpened drive shoe.
- * — Blow counts not recorded or not considered representative.
- Cobble or boulder (Core-drilled)
- Cobbles or boulders, continous or nested (Core-drilled and/or blasted and chopped)
- El. 1051.0 Elevation of bedrock surface
- Rock symbol
- Rock core recovery 0-25%
- Rock core recovery 25-50%
- Rock core recovery 50-75%
- Rock core recovery 75-90%
- Rock core recovery 90-100%



GEOLOGIC SECTION

(LOOKING UPSTREAM)

GRAPHIC SCALE

1" = 200' — 200' 0 200' 400'

LEGEND FOR PLAN

- ● FD-1 — Foundation Test Boring
- ■ FT-1 — Foundation Test Pit
- Location and Direction of View for Geologic Section

NOTES

Elevations refer to Mean Sea Level
Profile by NED Survey of Dec. 1961
Plan topography from U.S.G.S., enlarged and adjusted to profile survey and to portion of survey made in 1947 for N.H. Public Service Co.
Borings FD-4 and FD-5, located at the dike site.

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY	DR. BY	CK. BY
R.C.G.	R.D.B.	R.C.G.

SUBMITTED — CHIEF, GEOLOGY SECTION
CHIEF, F&M BRANCH
REVIEWED — PROJECT ENGINEER
APPROVED — CHIEF, P & R BRANCH

ANDROSCOGGIN RIVER BASIN, ME. & N.H.

PONTOOK PROJECT

GEOLOGY - MAIN DAM

ANDROSCOGGIN RIVER, NEW HAMPSHIRE

APPROVED — CHIEF, ENGINEERING DIVISION

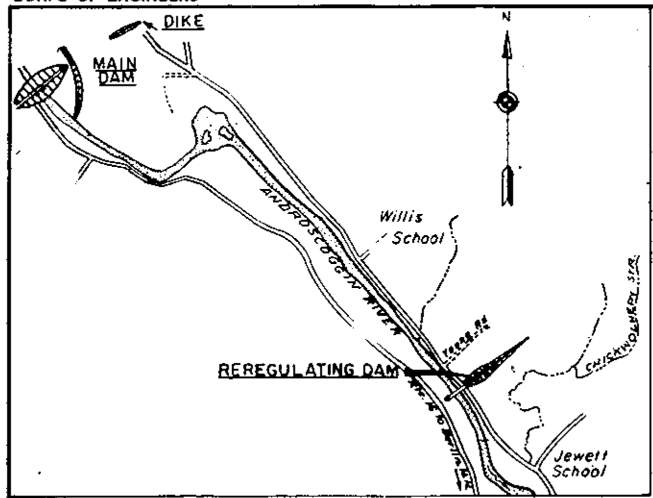
DATE APRIL 1965

TO ACCOMPANY REPORT DATED: 15 APRIL 1965

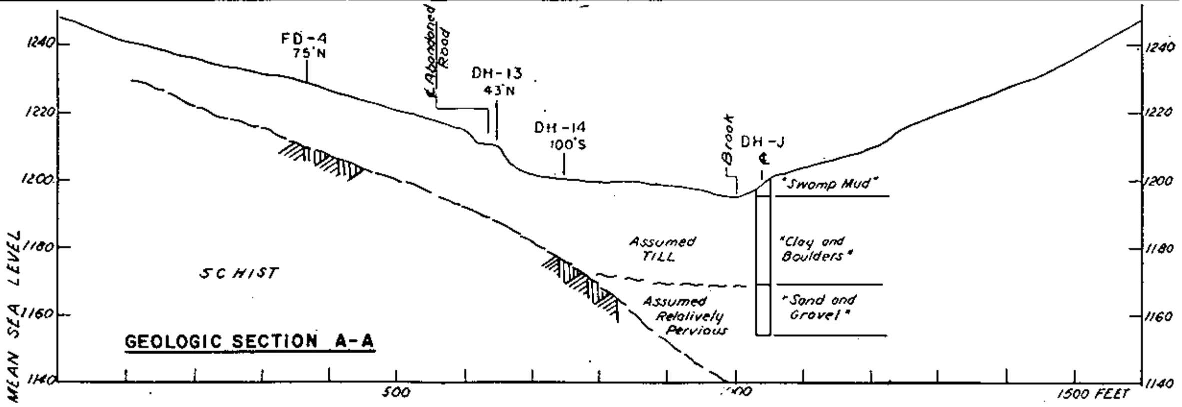
SCALE: AS SHOWN

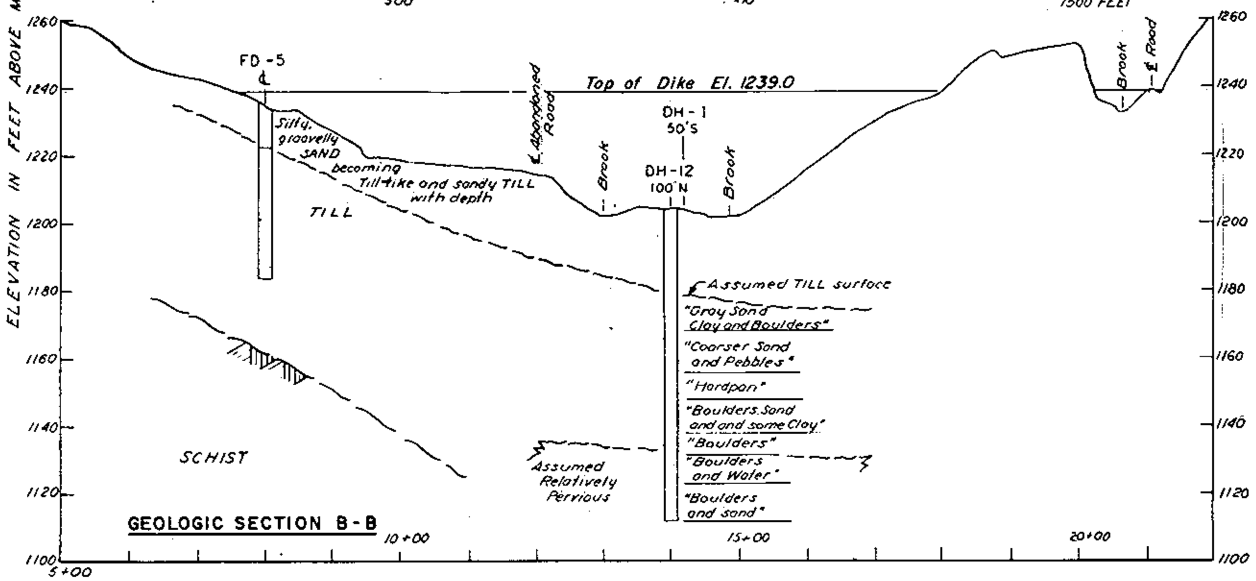
DRAWING NUMBER

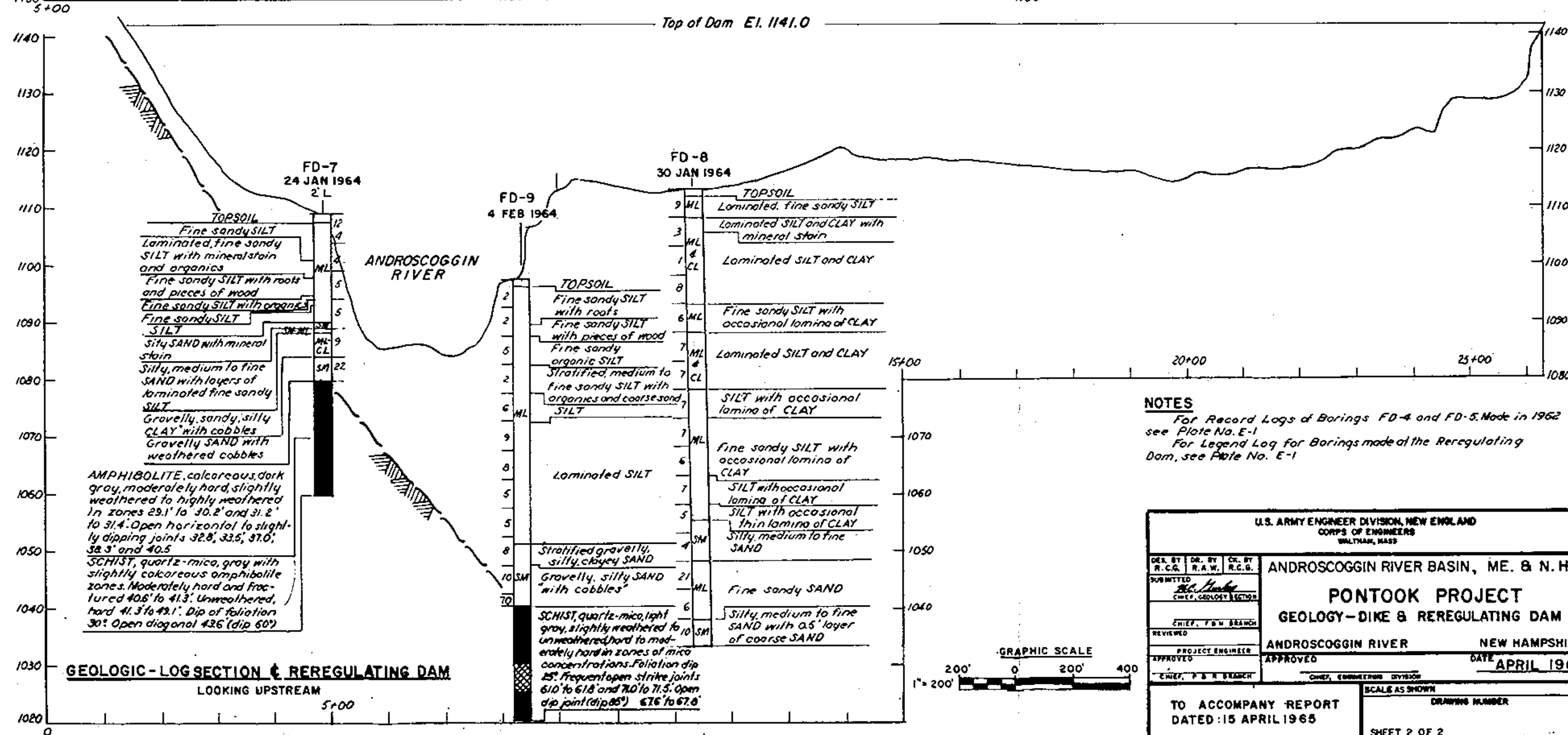
SHEET 1 OF 2



PROJECT MAP
SCALE: 1" = 2000'







EXPLORATIONS MADE IN 1946-1947 FOR NEPSCO SERVICES, INC.

DH-F

1195 Ground and Water
1190 Swamp Mud
1182 Clay and Boulders
1168 Clay and Boulders (Till)
1150 Gravel and Boulders

DH-I

1197 Ground Elevation
1193 Swamp Mud
1187 Boulders
1162 Clay
1155 Gravel

TP-8

Top Elevation 1178 Bottom Elevation 1161. Located at edge of swamp. Surface and subsurface water to about 10 feet depth where material became water-tight. Glacial Clay below 1168, (Till - 1169)

DH-E

1189.5 Ground Elevation
1179.5 Swamp Mud
1170.5 Clay and Sand - Hard (Till)
1156.5 Blue Clay (Till)
1151.5 Clay and Sand - Hard
1154.5 Sand and Gravel, very coarse

EXPLORATIONS MADE IN 1929 FOR INTERNATIONAL PAPER CO.

DH-13

1206 Ground - Clay
1199.8 Ledge
1187 Rock
1180.6 Gneiss Rock

DH-14

1201 Ground - Sand and Clay
1193 Sand, Clay, Gravel
1185 Sand, Clay, Hardpan, Boulders
1173 Sand, Clay, Boulders
1167 Soft Rock
1147 Same, Ledge Rock

DH 16

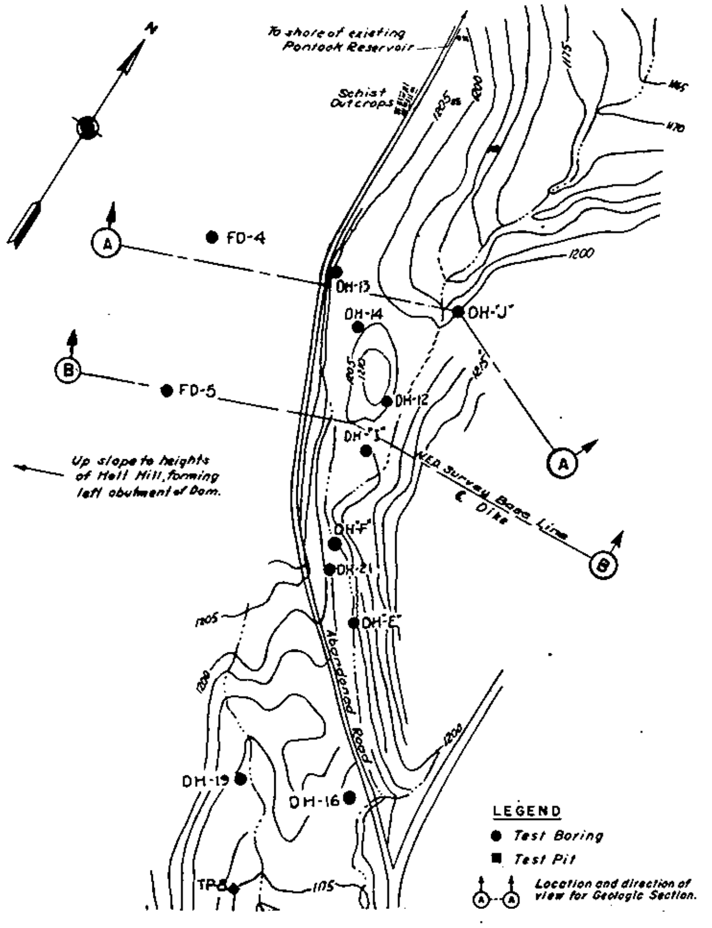
1181 Ground - Clay, Yellow Sand
1172 Medium Gray Sand
1167 Coarse Gray Sand
1156 Coarse Gray Sand, Clay
1147 Very Fine Sand and Clay
1146 Soft Broken Ledge
1121 Same 25' Diamond-Drilled

DH-19

1184 Ground - Muck and Blue Clay
1175 Pebbles - Gray Sand, Clay
1150 Sand and Gravel, Clay
1142 Boulder
1138 Sand
1130 Boulder
1118 Stones, Sand, Clay

DH-21

1195 Ground
1131 Boulders - Gray Sand - Clay



DIKE LOCATION
SCALE: 1" = 200'
(CONTOUR INTERVAL IS 5')

NOTES

For Record Logs of Borings FD-4 and FD-5 Made in 1962 see Plate No. E-1

For Legend Log for Borings made at the Reregulating Dam, see Plate No. E-1

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY	DR. BY	CK. BY
R.C.G.	R.A.W.	R.C.G.

SUBMITTED
CHIEF, GEOLOGY SECTION
CHIEF, F & M BRANCH
REVIEWED
PROJECT ENGINEER
APPROVED
CHIEF, P & R BRANCH

ANDROSCOGGIN RIVER BASIN, ME. & N.H.

PONTOOK PROJECT

GEOLOGY – DIKE & REREGULATING DAM

ANDROSCOGGIN RIVER — NEW HAMPSHIRE

APPROVED
CHIEF, ENGINEERING DIVISION

DATE APRIL 1965

TO ACCOMPANY REPORT
DATED: 15 APRIL 1965

SCALE AS SHOWN
DRAWING NUMBER
SHEET 2 OF 2

APPENDIX F

POWER STUDIES

APPENDIX F

POWER STUDIES

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PLATES

APPENDIX F

POWER STUDIES

1. GENERAL

Detailed power studies were made of two potential hydroelectric developments: the recommended Pontook project on the Androscoggin River above Berlin and the studied Hale project on the Swift River above Rumford. Flows at the two dam sites were determined from flow records at nearby USGS gaging stations and adjusted on a drainage area relationship to the specific site under study. For the Pontook project, observed flows and natural flows from the six lakes above Errol, were based on records at the Errol gage (drainage area 1,045 square miles) located 19 miles upstream of the dam site and observed flows from records at the Gorham gage (drainage area 1,363 square miles) located 15 miles downstream of the dam site. A gage on the Swift River near Roxbury (drainage area 95.8 square miles), 3 miles upstream of the Hale dam site, provided data for the Hale study. Stream flow records are available for the Errol gage since January 1905, for the Gorham gage since October 1913, and for the Roxbury gage since June 1929. Mass curves of observed and natural flows were developed through the critical low flow periods of record for the dam sites and the amount of storage and dependable flow derived. Upon advice from the Federal Power Commission, installations were based on a dependable capacity factor of approximately 10%. The methodology used in sizing and estimating the potential hydroelectric installations at the two projects was similar and is described in some detail for the Pontook project in this appendix.

2. PONTOOK PROJECT

a. Main Dam. At Pontook, the maximum pool level is controlled by the elevation of the town of Errol at the upstream end of the reservoir. The limiting elevation of 1220 feet m.s.l. is established by improvements in the town of Errol. Reserving 58,000 acre-feet for flood control establishes the maximum full power pool at elevation 1212. Stored flood waters will normally be released through the turbines which can empty the flood pool as rapidly as downstream channel capacities permit. Usable power storage of 141,000 acre-feet, between elevation 1212 and 1182, was selected as the practical optimum. Whereas additional storage could be used to increase the dependable flow, the increase would be relatively minor and the ratio of drawdown to total head would be too great for efficient operation. The minimum power pool at elevation 1182 will provide a dead storage pool of 39,000 acre-feet.

In determining the dependable flow at Pontook, it was assumed that the upstream storage in the reservoirs above Errol could be regulated to provide optimum flow at Pontook. Studies indicate that, by utilizing the 661,000 acre-feet of usable storage from the existing reservoirs above Errol and 141,000 acre-feet at Pontook, a minimum dependable flow of 1,675 cfs could be maintained. A mass diagram illustrating use of storage during the critical low flow period of 1940-1942 is shown on Plate F-1.

A system rule curve was developed for the entire 802,000 acre-feet of storage. This area was separated into three substorage areas and rule curves were developed for each of them as well as for Pontook Reservoir. Pertinent data relative to these substorage areas is given in the following table:

	Drainage Area (square miles)		Usable Power Storage	
Subarea	Gross	Net	Acre-feet	MSF
Aziscohos Dam	214	214	220,200	3,655
Storage areas at and upstream of Richardson Lakes	509	509	370,200	6,150
Errol Dam	1,045	322	70,700	1,175
Pontook Dam	1,215	170	141,000	2,340
TOTAL			802,100	13,320

Rule curves shown on Plate F-2 were tested for the period 1938-1959 which included the critical dry period of 1940-1942. Regulation of the March 1936 flood, following the rule curves, proved satisfactory and is discussed in detail in Paragraph 10h(1) of Appendix B. It was assumed that, when the storage was below the rule curves, water would be drawn in such a manner that the amount of storage required from each sub-area was proportional to its net drainage area. The only exception was Errol dam which contains 70,700 acre-feet of storage. This storage was always used before utilizing storage from the remaining areas and filled only after the other storage areas had been filled.

Although this method of operation is feasible for the combined use of power, recreation, and flood control, it is not considered the optimum operation. After reviewing the results, it is evident that, even during dry periods, Pontook storage could be kept on its rule curve, thereby increasing its average monthly head and providing greater annual energy benefits. More storage could be drawn from Aziscohos dam where no recreation is anticipated to compensate for changes at Pontook Dam. For determining average annual energy and recreation benefits, it was assumed that Pontook always remained on its rule curve and the required system storage was drawn from the other substorage areas. Further refinements to optimize the use of overall storage for all water uses will be explored during the design stage.

After deducting losses due to leakage and seepage, a December usable dependable flow of about 1,600 cfs was obtained. Operation of the reservoir for power production would result in a maximum gross head of 94 feet, an average net head of 82 feet, a net head during the December critical low flow period of 82 feet, and a minimum net head of 62 feet. Plate F-2 also illustrates that normal operation of the power pool would result in a constant lake level in the Pontook reservoir during the recreation season.

Flows to the power house, founded on rock at the downstream toe of the dam, would be through two 32' diameter, concrete-encased, steel penstocks. Two vertical Kaplan turbines, each capable of developing 65,000 horsepower at minimum head, would be direct-connected to two 67,500 kw generators for a total installation of 135,000 kw, all of which would be dependable at the time of the peak (December) load. During design stage, power needs, current and future will be re-evaluated to determine whether additional capacity should be installed or provision made for the installation of additional units at a future date. The plant would have an average annual capacity factor of 9.1% and a minimum December load factor of 5.4%. Average annual energy would amount to 107,000,000 kwh.

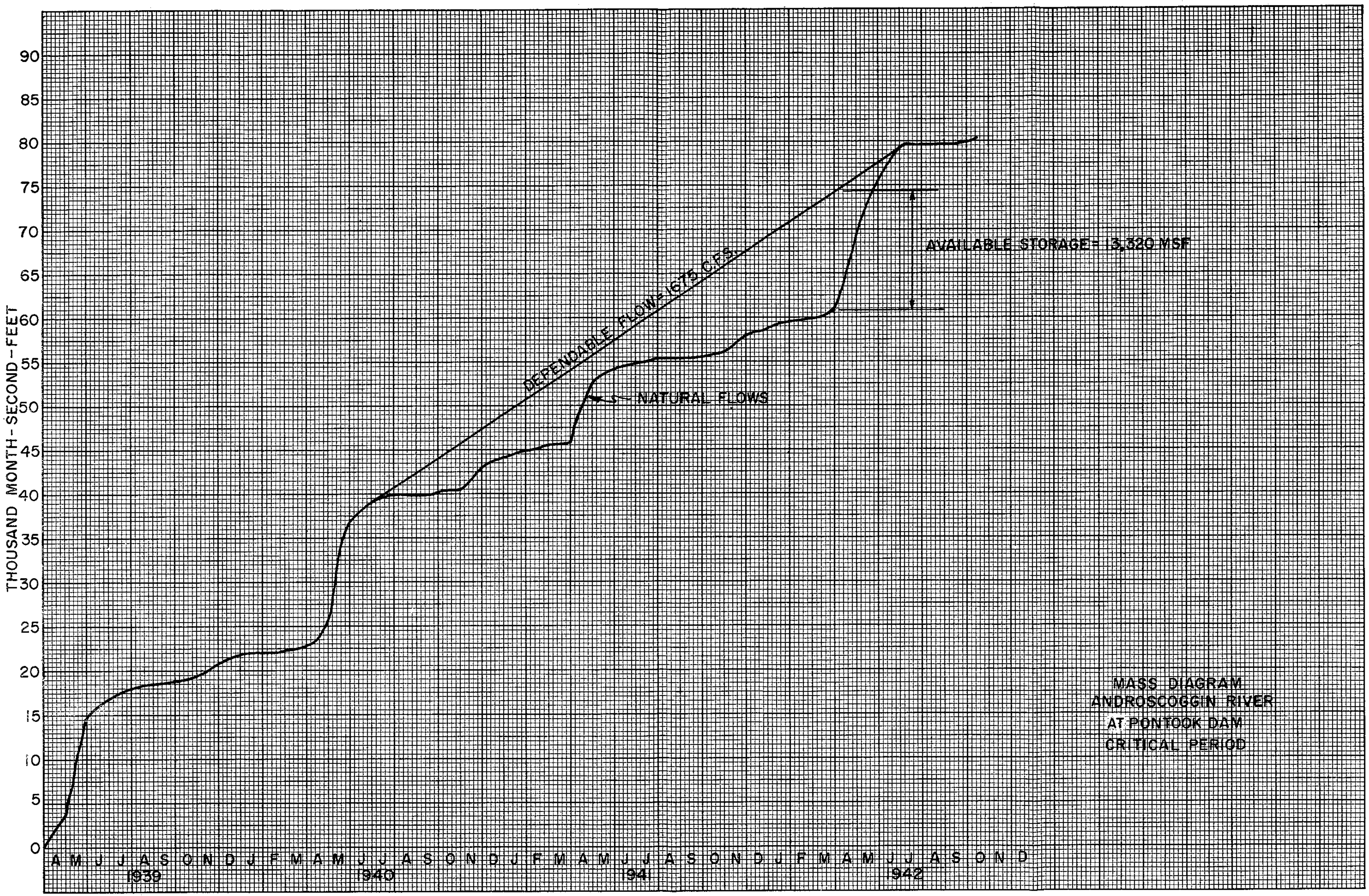
b. Reregulating Dam. Storage presently available in the six reservoirs above the Errol dam totals 661,000 acre-feet which is operated to provide uniform dependable flow at Berlin and points downstream for the benefit of paper mills and other water users. Surges caused by the peaking operation of the Pontook main power station would be reregulated by a dam located about $3\frac{1}{2}$ miles below the main dam. This would create a reservoir having a total capacity of 9,300 acre-feet at elevation 1118, the tailwater elevation at the main power house tailrace. A usable capacity of 4,100 acre-feet would permit reregulation of the Pontook discharges to uniform flow conditions. Studies found that it is economical to install a horizontal propeller turbine connected through a speed increaser to a 3,000 kw generator. The plant would be operated on a 69% capacity factor and be capable of developing an average annual output of 18,000,000 kwh. Flows from the main power house in excess of the capacity of the reregulating dam power station would be released through control gates or passed over the fixed crest spillway.

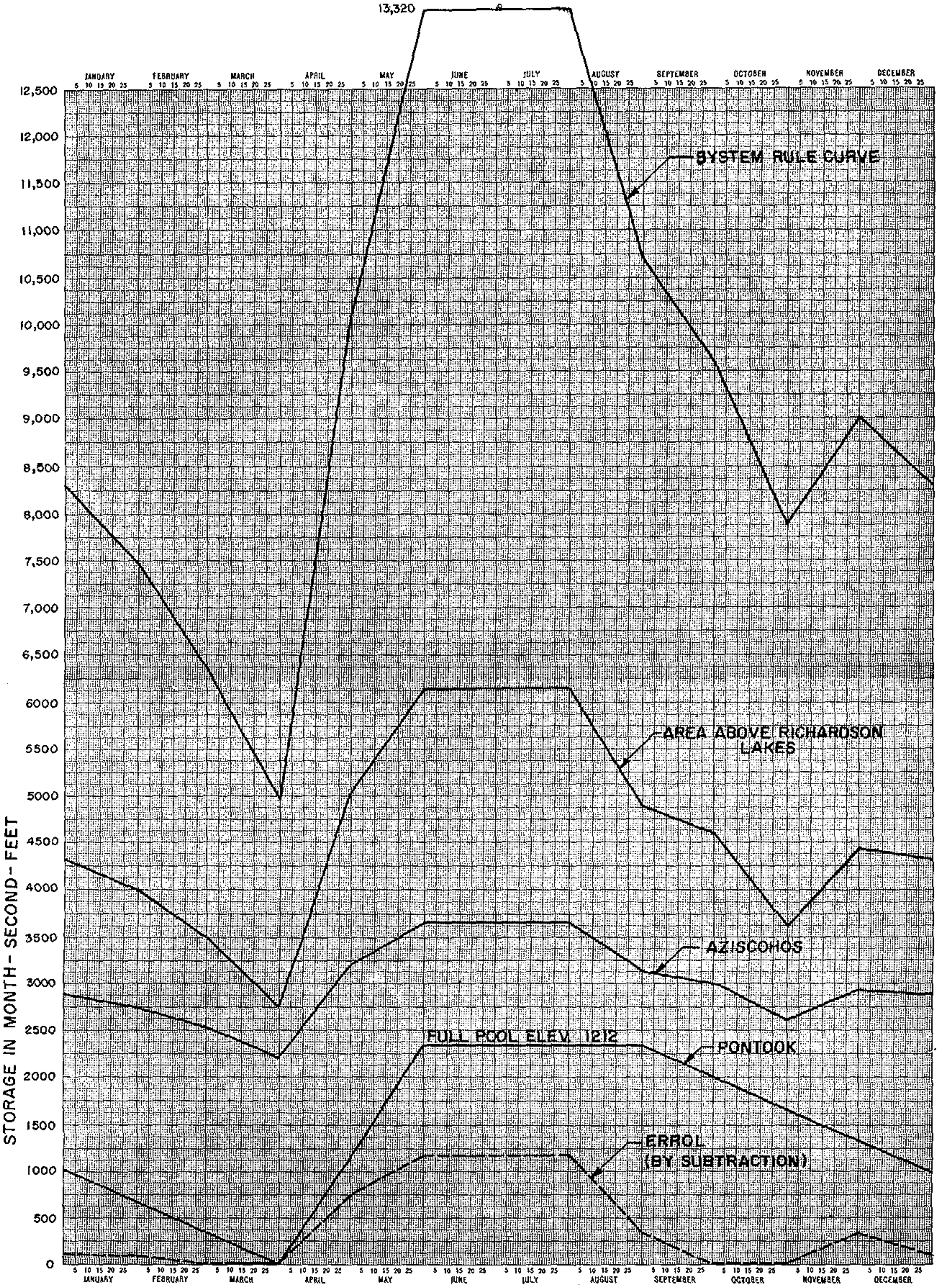
c. Betterment of Downstream Flow Conditions. Average monthly flow records at the Gorham gage show that, of the 261 months studied between 1938 and 1959. 22 months showed flows less than the minimum of 1550 cfs which is desired by the water users on the river, the lowest flow being 1257 cfs. The reregulating dam at Pontook would provide a minimum dependable release of 1675 cfs which would permit generation of an additional 19,000,000 kwh annually at existing downstream installations.

d. Plans of the project power houses and installations are shown on Plate 5 of the main report.

3. PUMPED STORAGE POTENTIAL

During design stage, consideration will be given to installation of integral type, reversible pump-turbines at Pontook since the pool created by the reregulating dam would be suitable for use as an afterbay for such a development. Information at this stage of the study is insufficient to fully evaluate the need for and the economic justification of such an installation.


THOUSAND MONTH-SECOND-FEET
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
DEPENDABLE FLOW=1675 C.F.S.
NATURAL FLOWS
AVAILABLE STORAGE=13,320 MSF
MASS DIAGRAM
ANDROSCOGGIN RIVER
AT PONTOOK DAM
CRITICAL PERIOD



PONTOOK PROJECT
RULE CURVES

PLATE F-2

APPENDIX G

RECREATIONAL DEVELOPMENT

APPENDIX G

RECREATIONAL DEVELOPMENT

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APPENDIX G

RECREATIONAL DEVELOPMENT

1. INTRODUCTION

The recommended Pontook Dam and Reservoir project, located on the Androscoggin River in the White Mountain area of northern New Hampshire, is highly favorable for recreational development. The 2,000-foot long dam, with a height of 115 feet above stream bed, would impound a 6,500-acre lake of crystal clear Androscoggin River water extending 15 miles up the river valley and creating the second largest water area in New Hampshire, surpassed in size only by Lake Winnipesaukee. Tremendous recreational use potential in this project results from the high incidence of people in thickly populated areas of New England and adjoining regions who would vacation or visit here, drawn by the scenic splendors and the opportunities for recreation. Details of the recommended development for recreation, including economic factors, are described in this Appendix.

2. DEMAND FOR RECREATION

a. General. The demand for outdoor recreational opportunities in New England and the northeastern states is high and is continuing to rise. The Outdoor Recreation Resources Review Commission study report number 8, "Potential New Sites for Outdoor Recreation in the Northeast" states "Population, income, leisure time, mobility and length of life statistics indicate that demand for outdoor recreation will rise." The most dominant factor in the demand for recreational facilities is the high density of population, with New England having 6 percent of the nation's population and the northeastern states having 25 percent. This becomes most significant when one considers that New England covers only 2 percent of the area of the continental United States and the Northeastern States only 5 percent.

b. Use of Existing Facilities. Development of recreational facilities at reservoirs constructed by the Corps of Engineers has provided added opportunities for the outdoor recreation seeker in New England. Attendance increased from 470,000 to 2,860,000 between 1960 and 1963 at these reservoirs and the Cape Cod Canal. It is noteworthy that facilities at 16 projects opened during this period were put to intensive use immediately on being made available to the public.

Use of park facilities offered in New Hampshire has more than doubled since 1951 as shown in Figure 1. In 1963, the attendance was nearly 2.7 million at State Parks designed for 1.5 million users.

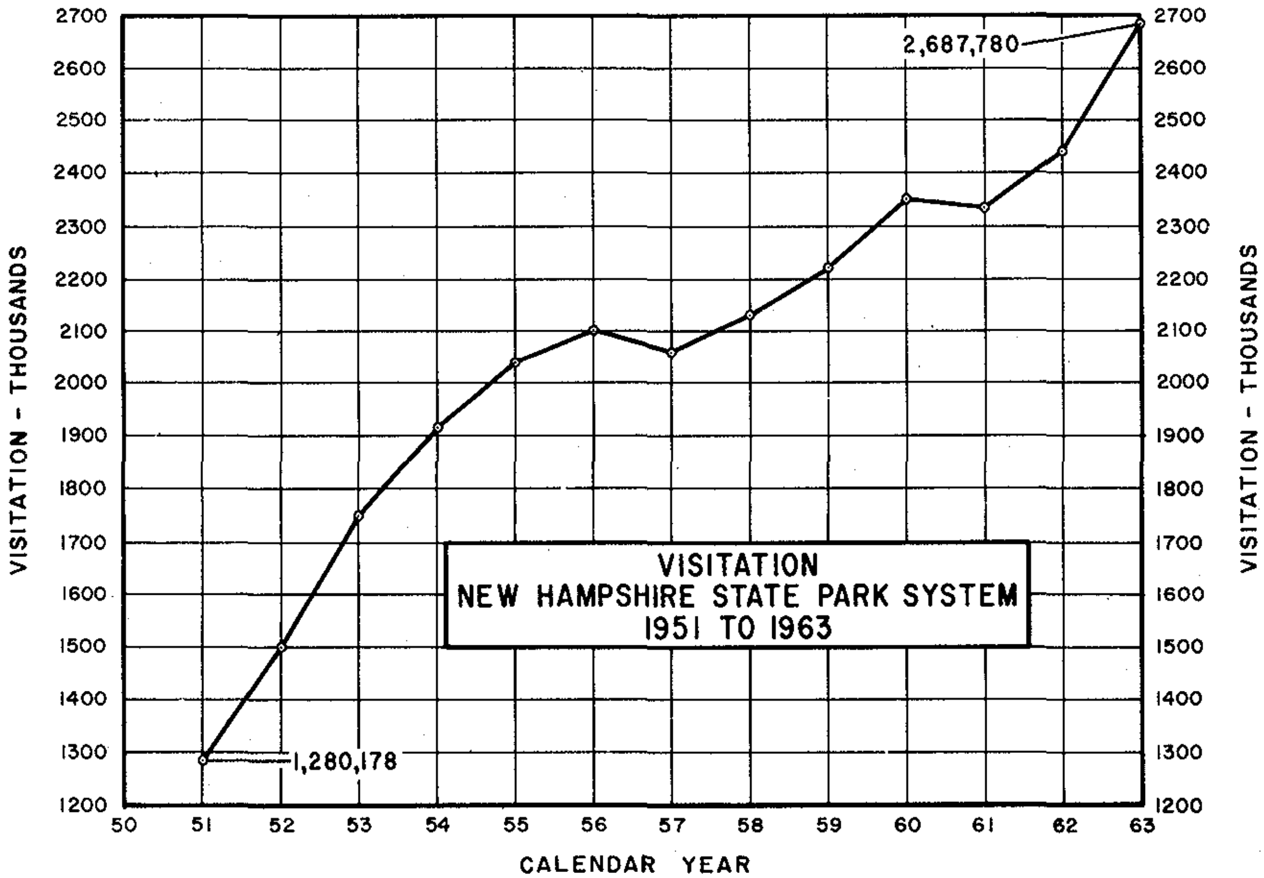


FIGURE 1

c. Demand for Water-Based Recreation. Water-based recreation is the most desired outdoor activity. The Outdoor Recreation Resources Review Commission's "National Recreational Survey" reports that 44 percent of the U. S. population prefers water-based recreation activities over any others and that recreation on land such as camping and picnicking is enhanced by being near water.

The primary use of the White Mountains is for sightseeing, hunting, fishing, hiking, and camping. There is also a strong inherent demand by the using public for water-based recreation in view of the significant lack of publicly-oriented lake-type resources in the region.

3. RECREATIONAL POTENTIAL OF THE PROJECT

a. Potential Public Use. In order to determine the potential public use of the proposed reservoir project, many factors were investigated and their effect and relation to public use of the project determined. The basic factors which will determine the development of the reservoir are the inherent use potential in the people who are expected to create use pressure and the quality and quantity of resources which the project can tap. The natural attractions of the area in which the project is located constitute a very important resource.

b. White Mountain Area.

(1) General. The White Mountain region constitutes the greatest inland tourist attraction in New England. The history of the recreational use of the White Mountains includes the beginnings of outdoor recreation in America. Mount Washington (6, 288 feet, m. s. l.) was first climbed in 1642 by Darby Field only 22 years after the landing of the Pilgrims. From that time on, the area has been a favorite attraction to millions of recreation seekers.

(2) Scenic Interest. From the peak of Mount Washington on a clear day, one can see a panorama of ranges and valleys extending for nearly 100 miles and taking in landmarks in Maine, Vermont, and Massachusetts. The peak dominates this area of New Hampshire, a region filled with rugged scenic notches carved between the mountains, gorges marked by forested slopes laced with cascading streams, and outstanding natural rock formations. Among well known features are "the Flume"; Crawford, Pinkham and Franconia Notches; the "Pool", and "Basin", filled with crystal clear water; picturesque Glen Ellis Falls and the Crystal Cascade; and - most famous, - the Old Man of the Mountains, lifting its face to the ages.

(3) Recreational Resources. The most significant recreation resource in the region is the White Mountain National Forest. Two State parks within the limits of this National resource and within 50 miles of the proposed project present the greatest attraction to the recreation seekers. These are Crawford Notch and Franconia Notch which together received over 95 percent of the 1963 total visitor-day use of all the State parks within a 50-mile radius of the project.

(4) Types of Activities. Since the main activities in the White Mountain area are viewing its scenic splendor, hiking, camping, and fishing, the area has long been an attraction, especially to the outdoor type of person who can roam the mountain tracts for days, stopping overnight at campsites, shelters, and cabins. The fishermen can find in the rivers, streams and cascading waterfalls, excellent trout fishing. However, what the general recreation seeker wants and cannot find is water suitable for swimming and boating. Thus, the greatest attraction to most outdoor enthusiasts is lacking in the area.

(5) Tourist and Vacation Trends. The scenic charm of the White Mountains is a perennial lure, alike to the sophisticated or the work-weary visitor. It has supplied the Nation since the early seventeenth century with opportunities for recreation. The area is well developed with motels, hotels, and cottages for transient and vacation use. Surveys have shown that visitation to the area has practically doubled in the past decade.

(6) Existing Park and Recreational Areas. Within a 50-mile radius of the project, there are 13 developed public recreation areas, exclusive of the White Mountain National Forest, offering public-use facilities. They include approximately 20,000 acres of land. Eight of the areas offer bathing facilities, but on a small scale due to lack of shore front ownership. The only public access to a sizeable water surface at any of the recreation areas is at the 469-acre Maidstone State Forest on the shore of the 1,500-acre Maidstone Lake in Vermont.

The largest water area open for public use is the New England Power Company's Moore Reservoir. The reservoir has approximately 4,000 acres of water surface and facilities are available for public boat launching and picnicking on adjacent lands. No bathing facility is offered.

None of the six Corps of Engineers' flood control reservoirs in New Hampshire are within the 50-mile zone of influence. Two of them, the recently completed Hopkinton-Everett Reservoir and the Otter Brook Reservoir, completed in 1961, offer recreational developments. Facilities are provided at both for picnicking, swimming, boating and fishing.

The largest tourist attraction offering public-use facilities within a 50-mile radius of the project is the White Mountain National Forest. Eighty percent or approximately 550,000 acres of this National reserve lie within this radius. The main attraction of this area is its natural scenic beauty and developed camp grounds and hiking trails. There is only one developed swimming area and no water area large enough or having access facilities for boating. Table 1 lists the recreation areas and facilities offered.

d. Suitability of Reservoir for Recreational Development. The Pontook Reservoir would be ideally adapted for recreational develoment. The permanent pool would create the second largest water area in New Hampshire, surpassed in size only by Lake Winnipesaukee. The shoreline of the permanent pool has adequate slopes to support beach development, requiring only clearing and placing of a sand blanket by way of construction work. The adjacent land is highly diverse. It is well forested and readily adaptable to day use and overnight camping development. The mountain streams located in the area add to the aesthetic value of the land as well as supply a source of water for the recreation area. There is adequate land area composed of gently sloped rolling hills to support development. There is also the steep rising Sugar Hill which rises 450 feet above the proposed 6,500-acre lake and offers ideal terrain for hiking tracts with a panoramic view of the lake and the surrounding mountain side. In general, the area around the proposed Pontook Reservoir exhibits spectacular scenery and provides a wide variety of recreational possibilities.

e. Climate. The air in the White Mountains area is dry and clear and a favorite for sufferers of hay fever. In 52 years of record, the minimum and maximum temperatures in Berlin, New Hampshire have been -44°F and plus 100°F. The summers are pleasant with an average temperature around 70°F. Average precipitation in Berlin is 40 inches with an average winter snowfall amounting to 100 inches.

f. Fish and Wildlife Resources. Fish and wildlife resources of the project are discussed in Appendix H of this report.

g. Accessibility. The proposed Pontook Reservoir will be easily accessible by east-west U. S. Route 2 and north-south State Route 16. Both roads are paved two- and three-lane highways. The driving distance from Boston, Massachusetts is 180 miles or approximately four hours leisurely driving time. It is within seven hours driving time of almost all of New England and New York City or within the average driving range which would be considered for a vacation trip.

TABLE 1

EXISTING PUBLIC PARK AND RECREATION AREAS WITHIN
50 MILES OF THE PROPOSED PONTOOK RESERVOIR

	Facilities Offered								
NEW HAMPSHIRE	Bathing	Boating	Camping	Fishing	Hiking	Picnicking	Scenic Road	Skiing	Land Area (acres)
Milan Hill S.P.			X			X			127
Mount Prospect S.P.						X	X		430
Moose Brook S.P.	X		X	X	X	X			755
Forest Lake S.P.	X	X		X		X			420
Crawford Notch S.P.			X	X	X	X	X		5950
Franconia Notch S.P.							X	X	6275
Echo Lake	X			X	X	X			
Flume Gorge					X	X			
Lafayette Campground			X	X	X	X			
Profile Lake				X	X	X			
Echo Lake S. P.	X				X	X	X		405
VERMONT									
Brighton S. P.	X		X	X	X	X			59
Darling S.P.			X		X	X		X	1705
Maidstone S.F.	X	X	X	X	X	X			469
NEW HAMPSHIRE-VERMONT									
Moore Reservoir		X		X	X	X			
WHITE MOUNTAIN NATIONAL FOREST									
C. L. Graham Wangan Ground					X	X	X		
Cold River Campground			X	X	X	X	X		
Covered Bridge Campground			X	X	X	X	X		
Dolly Copp Campground			X	X	X	X	X		
Dugway Campground			X	X	X	X	X		
Glen Ellis Falls Scenic Area					X	X	X		
Long Pond Camp			X	X		X			
Lower Falls Picnic Area				X		X	X		
Oliverian Campground			X	X	X	X			
Passaconaway Campground			X	X	X	X	X		
Rocky Gorge Scenic Area				X	X	X	X		

TABLE 1 (cont.)

EXISTING PUBLIC PARK AND RECREATION AREAS WITHIN 50 MILES OF THE PROPOSED PONTOOK RESERVOIR

	Facilities Offered								
WHITE MOUNTAIN NATIONAL FOREST (cont.)	Bathing	Boating	Camping	Fishing	Hiking	Picnicking	Scenic Road	Skiing	Area (acres)
Russell Pond Campground		X	X	X	X		X		
Sawyer Rock Picnic Area				X		X	X		
South Pond Recreation Area	X			X	X	X			
Sugarloaf Campground			X	X	X	X			
Tuckerman Ravine			X		X			X	
Waterville Campground			X	X	X	X			
White Ledge Campground			X		X	X			
Wild River Campground			X	X	X	X			
Wildwood Campground			X	X		X			
Zealand Campground			X	X	X	X			
MAINE									
Mount Blue S.P.	X		X	X	X	X	X		1284

NOTE: S.F. - State Forest

S.P. - State Park

4. ANTICIPATED PROJECT USE

a. The Desirability of the Project. The water area offered by the project would be the major attraction of the Pontook Reservoir. The 6500-acre water surface which will be available during the summer use season will provide opportunities for swimming, boating, water skiing, and fishing. It will also offer an attraction for such land-oriented activities as picnicking, hiking, and camping. The project land area is expected to receive a more than average use by campers. Other leisurely uses such as walking by the water, bird watching, and sightseeing will receive increased usage. The area is presently hunted over and such use will continue with the project.

b. Population Potential. The main factor determining the recreational development of the reservoir project is the use potential in the population expected to create use pressure on the project. To determine the use potential, it was necessary to determine the present and potential population, employment, income, and available leisure time of the people and the effect these factors would have on their desires to participate in the recreational opportunities offered by the project.

(1) Population. Within a 15-mile zone of influence of the project, there are some 21,000 inhabitants. The one-hundred mile zone of influence encompasses some 525,000 people, and the 200-mile zone over 10 million.

(2) Income. The median income of families within a 15-mile radius of Pontook Reservoir in 1960 was $5,200 with 76 percent of the families with incomes between $3,000 and $10,000 and eight percent with incomes of $10,000 or over. Median family incomes of the entire zone of influence were higher largely because of the effect of Massachusetts, Connecticut and New York. The median family income of the entire zone was about $6,100 with 70 percent of the families with incomes between $3,000 and $10,000 and 16 percent with incomes of $10,000, or over. (1)

Participation in outdoor activites increases with income, the increase being the sharpest at about $3,000 a year; from this level on, participation steadily increases reaching a maximum in the $7,500-$10,000 bracket then declining slightly thereafter. (2)

(1) U.S. Dept. of Commerce, Bureau of the Census
(2) Outdoor Recreational Resources Review Commission, Main Report, 1962

(3) Education. Of all persons 25 years old and over within the zone of influence of the Pontook Reservoir, the median school years completed were over 11.(1) Education affects participation much as does income; the more education adults have, the more active they are likely to be.(2) The percentage of persons participating in outdoor activities is higher among the group with more than three years of high school than among those with less education.

(4) Employment. Occupation has a considerable influence on participation in outdoor activities. The greatest participation was by the non-labor force. Among occupations, professional people enjoy the most recreation and farm workers the least. Within the Pontook zone of influence, about 60 percent of the population belonged to the non-labor force. Of the employed labor force, about 42 percent were in white collar occupations and about 37 percent were in manufacturing industries. (1) About two percent of total population were of the rural farm type for the entire zone and five percent for the immediate area.

(5) Leisure Time. In special studies conducted by the Bureau of Labor, statistics confirm the trend toward a shorter than 40-hour week. All figures point to a continuation of this trend into the future. More time will be available to participate in outdoor recreation, and this increase will bring greater pressure upon existing facilities. It will also increase the demand for expansion of existing facilities and the development of new recreation facilities. Greater opportunity is urgently needed in the densely-populated New England area to meet the mounting needs and demands of the majority of the residents who are primarily skilled wage earners. Some of the demand can be satisfied in the after-work and weekend hours at the Pontook Reservoir.

c. The Recreational Market. The source of the recreational market had to be considered in order to plan project development. The major portion of the recreational market of the Pontook Reservoir is expected to be comprised of visitors from New Hampshire and Massachusetts with visitors from New York having somewhat less significance. Rounding out the market will be visitors from Canada, Vermont, Maine, Connecticut, Rhode Island, New York, New Jersey and other parts of the United States. This assumption is predicated on 1943 and 1963 surveys by the State of New Hampshire to determine the origin of visitors to their State Park System. The 1963 survey shows that approximately 78 percent of visitor-days was non-resident. This indicates an increase of 23 percent since 1943. Results of these surveys, shown in Table 2, are based on a sampling of 10 percent of day users and 25 percent of campers.

(1) Ibid
(2) Ibid

TABLE 2

SOURCE OF VISITORS BY STATE

Percentage of Total Visitor-Days

State	1943 Study	1963 Study
Maine	2	2
New Hampshire	45	22
Vermont	1	1
Massachusetts	32	39
Rhode Island	2	3
Connecticut	3	5
New York	7	11
New Jersey	5	3
Other (Includes Canada)	3	14

The more recent survey shows that 61 percent of the visitors come from Massachusetts and New Hampshire. It is assumed that the source of the majority of Massachusetts visitor-days is people in eastern Massachusetts, including the 2.6 million people residing in the Boston Metropolitan area. A cross-sectional analyses of the income, education, employment, and leisure time of the people of Massachusetts and New Hampshire reveal that the majority of these are within the group which desires to participate in public outdoor recreational activities.

Another important factor which will influence use of the Pontook Reservoir is the high number of seasonal residents in New Hampshire and especially in the White Mountain Area. According to 1960 census figures, the year-round population of New Hampshire is 607,000 with an increase of 214,000 in the summer season. There are 55,000 year-round residents and approximately 30,000 additional residents in the summer season within a 50-mile radius of the project in New Hampshire, including approximately 80 percent of the White Mountain National Forest. In the period 1957 to 1960, summer season residency increased 87 percent in New Hampshire.

d. Estimated Visitor-Days. The Pontook Reservoir is expected to exert an influence on the recreational desires of a large area of the Northeast including New England, New York and New Jersey as well as the Province of Quebec, Canada. It is assumed that 30 percent of the visitor days will come from surrounding communities within a 50-mile radius of influence and 25 percent will come from the zone of influence between 50 and 100 miles from the project. Based on recent surveys by the State of New Hampshire, it is also reasonable to predict that 40 percent of the visitor-days will come from the Metropolitan areas in Massachusetts, Connecticut, New York, New Jersey, and Quebec, Canada, with the remaining five percent coming from various other locations.

It is conservatively estimated that visitors from the above areas would amount to 110,000 visitor-days upon completion of recreational development of the project. Over the 100-year life of the project the visitor-days would rise, as shown in Figure 2, and reach 404,000 annual visitor-days by project year 100.

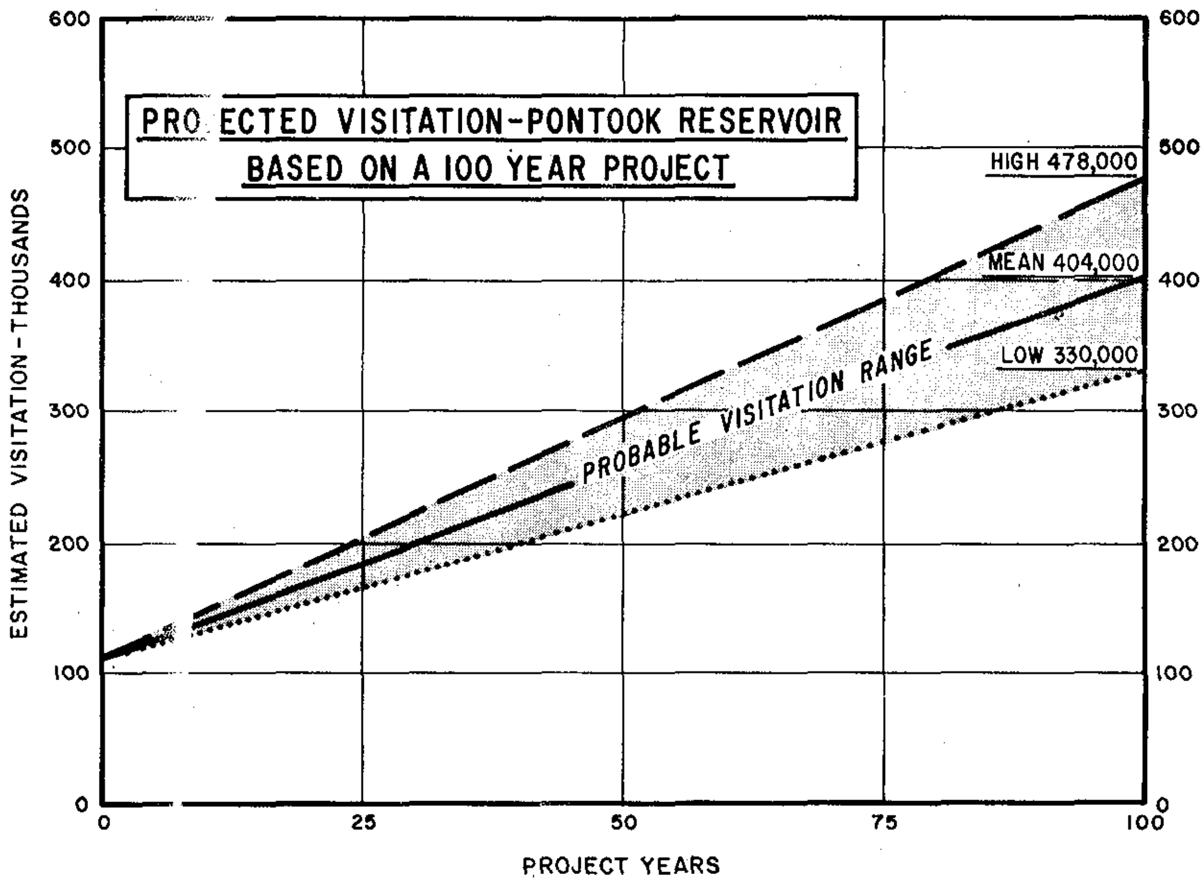


FIGURE 2

These figures represent visitors using developed recreation facilities and do not include sightseers to view the project or hunters and fishermen. The project is expected to attract approximately 200,000 sightseer visitor-days annually. The Pontook development would not compete with the land-based attractions of the White Mountain area but would supplement them by offering to the visiting public a water area of significant size presently lacking in the area.

5. DEVELOPMENT PLAN

a. General. The area chosen for initial and future recreational development is shown on Plate G-1. This is the area considered to be most practical in terms of terrain, cover, access, and economical development. The development layout shown is schematic in nature and depicts a typical layout which would be determined after extensive field work and engineering analysis in master planning the project.

The number of facilities provided was determined on a design load basis. Design load was determined by use of the National Park Service formula:

$$D.L. = \frac{1}{14}\left(\frac{x(AV \times .80)}{1.5}\right) \times .60$$

in which:

D. L. = Design Load
AV = Annual Visitation
1/14 = Number of summer Sundays, inversely
.80 = Percent of attendance that will use facilities during normal 14-week season.
.60 = Percent of weekly visitors on a normal summer Sunday.
1.5 = Rate of turnover

This formula, tried against experienced use at completed developments at New England Division Reservoirs, has proved to be fairly accurate. The initial design load for the project, based on an annual visitation of 110,000, is 2500. The initial development will have facilities adequate to accommodate the design load. The initial development will also include basic facilities which will be qdequate for future as well as initial demand and which are more economically constructed in one stage rather than multi-stage. Such facilities include the administration and maintenance area, central roads, water supply, sewage disposal area, and beach development. The development will be expanded for future use over the life of the project based on design loads derived from the projected visitation shown in Figure 2, and/or as experienced use of the project may indicate.

b. Purchase Area. In order to realize utilization of the full potential of the resources of the Pontook Reservoir, it will be necessary to acquire additional land for recreational uses over and above that required under normal procedures. This area is shown on Plate G-1 and is designated as "Recommended Project Boundary". This land is prime development land and offers adequate area for land-based recreational development as well as to insure against encroachment by private enterprise along the relocated Route 16.

c. Development Features. Initial development to accommodate a design load of 2,500 users will have provisions for necessary access and a circulatory road network with adequate parking area for 500 cars. The picnic areas will have 75 picnic sites consisting of two picnic tables and one fireplace for each site and selective clearing as necessary. There will be 100 developed campsites with one picnic table and one fireplace each with an adequate cleared space for tent or trailer siting. Approximately 90,000 square yards of beach area will be developed to accommodate the initial anticipated use as well as the visitations for project year 100. It is considered desirable to develop the entire beach area initially as one stage construction in the interests of economy. Furthermore, future lowering of the pool for construction in multi-stage would most likely conflict with water needs for other purposes as well as hinder recreational use of the water surface.

The provision of the 6,500-acre water surface is expected to attract a large amount of boat use for pleasure boating and boat fishing. To accommodate these uses, a parking area for 120 cars with trailers and 40 cars without trailers will be provided. Mooring facilities will also be provided.

Central water supply and sewage disposal facilities will be developed for initial and projected use. Adequate toilet facilities will be provided in the initial development and supplemented as future use pressure requires.

Interpretive signs and tracts will be located where necessary.

6. ECONOMIC EVALUATION

a. Costs. Table 3 itemizes the facilities and cost for initial development of the Pontook Reservoir. The initial cost of development is $1,000,000 with a total accumulated cost of $2,200,000 by project year 100. These costs include cost of basic facilities and do not include cost of land acquisition and project modifications. Figure 3 shows the accumulated project cost for incremental 5-year periods of the 100-year project life.

TABLE 3

PONTOOK RESERVOIR COST ESTIMATE
INITIAL RECREATION DEVELOPMENT

Item	Quantity	Unit Price	Estimated Cost
DAY USE - PARK AREA			
1. Roads - Dbl. Bit. Treatment	5 mi.	$25,000	$ 125,000
2. Parking Areas	17,000 s.y.	2.00	34,000
3. Beach Development	90,000 s.y.	1.25	112,500
4. Picnic Tables	150 ea.	100.00	15,000
5. Fireplaces	75 ea.	90.00	6,750
6. Trash Barrels	150 ea.	10.00	1,500
7. Sanitary Facilities			
1 central change house toilet structure at beach area w/provisions for management and storage facilities. 16 change stalls, 12 water closets & 4 urinals. Flush-type toilets	1 job	80,000	80,000
2 toilet structures w/1 urinal & 5 water closets each	2 ea.	20,000	40,000
		Sub Total	414,750
CAMPING AREA			
1. Roads - Dbl. Bit. Treatment	0.4 mi.	25,000	10,000
Gravel Surface	1.6 mi.	15,000	24,000
2. Campsites	100 ea.	200.00	20,000
3. Picnic Tables	100 ea.	100.00	10,000
4. Fireplaces	100 ea.	90.00	9,000
5. Trash Barrels	200 ea.	10.00	2,000

TABLE 3 (cont'd.)

Item	Quantity	Unit Price	Estimated Cost
CAMPING AREA (cont'd.)			
6. Toilet structure w/urinal, 5 water closets, 2 shower stalls and 1 laundry tub	2 ea.	$ 22,000	$ 44,000
		Sub Total	119,000
BOAT LAUNCH & MARINA AREA			
1. Parking Area	6,000 s.y.	2.00	12,000
2. Boat Launch Ramp	2 ea.	5,500	11,000
3. Building w/2 toilets and office space - 20' x 28'	1 ea.	10,000	10,000
4. Mooring Facilities	1 ea.	4,000	4,000
		Sub Total	37,000
ADMINISTRATION & MAINTENANCE AREA			
1. Entrance Station - 10' x 10'	1 ea.	4,000	4,000
2. One 4-stall garage w/office, toilet & workshop	1 ea.	25,000	25,000
3. One 5-room resident's quarters	1 ea.	24,000	24,000
		Sub Total	53,000
CENTRAL WATER SUPPLY SYSTEM			
To be created by using embankment of Relocated Rte. 16 to impound water			
1. Alterations to Rte. 16	Job	5,000	5,000
2. Pipe lines @ 4.5' depth			
2" line	8,500 ft.	4.00	34,000
3/4" line	8,000 ft.	3.00	24,000
3. Booster Pump Station	1 ea.	8,000	8,000
		Sub Total	71,000

TABLE 3 (cont'd.)

Item	Quantity	Unit Price	Estimated Cost
MISCELLANEOUS			
Trails	4 mi.	$2,500	$10,000
Landscaping - Use $1.50/D. L. visitor (N.P.S.)	Job	3,750	3,750
Signs and Markers (Material only - work done in NED workshop)	Job	1,000	1,000
		Sub Total	14,750
TOTAL CONSTRUCTION COST			709,500
Contingencies			140,500
		TOTAL	850,000
Engineering & Design			80,000
Supervision & Administration			70,000
TOTAL COST INITIAL DEVELOPMENT -			$ 1,000,000

AVERAGE ANNUAL COSTS	
Operation & Maintenance	$20,000(1)
Replacement	32,000(2)
Total	$52,000

(1) Annual Operation and Maintenance costs increase from $11,000 in year one to $41,000 in year 100. Increase = 41,000 - 11,000 = $30,000

Average annual equivalent factor for 100 years at 3-1/8% = .28168

Average annual operation and maintenance = 11,000 + (30,000 x .28168) = $20,000 (rounded)

(2) Annual replacement costs for recreation facilities increase from $23,000 in year one to $55,000 in year 100. Increase = 55,000 - 23,000 = $32,000

Average annual equivalent factor for 100 years at 3-1/8% = .28168

Average annual replacement = 23,000 + (32,000 x .28168) = $32,000

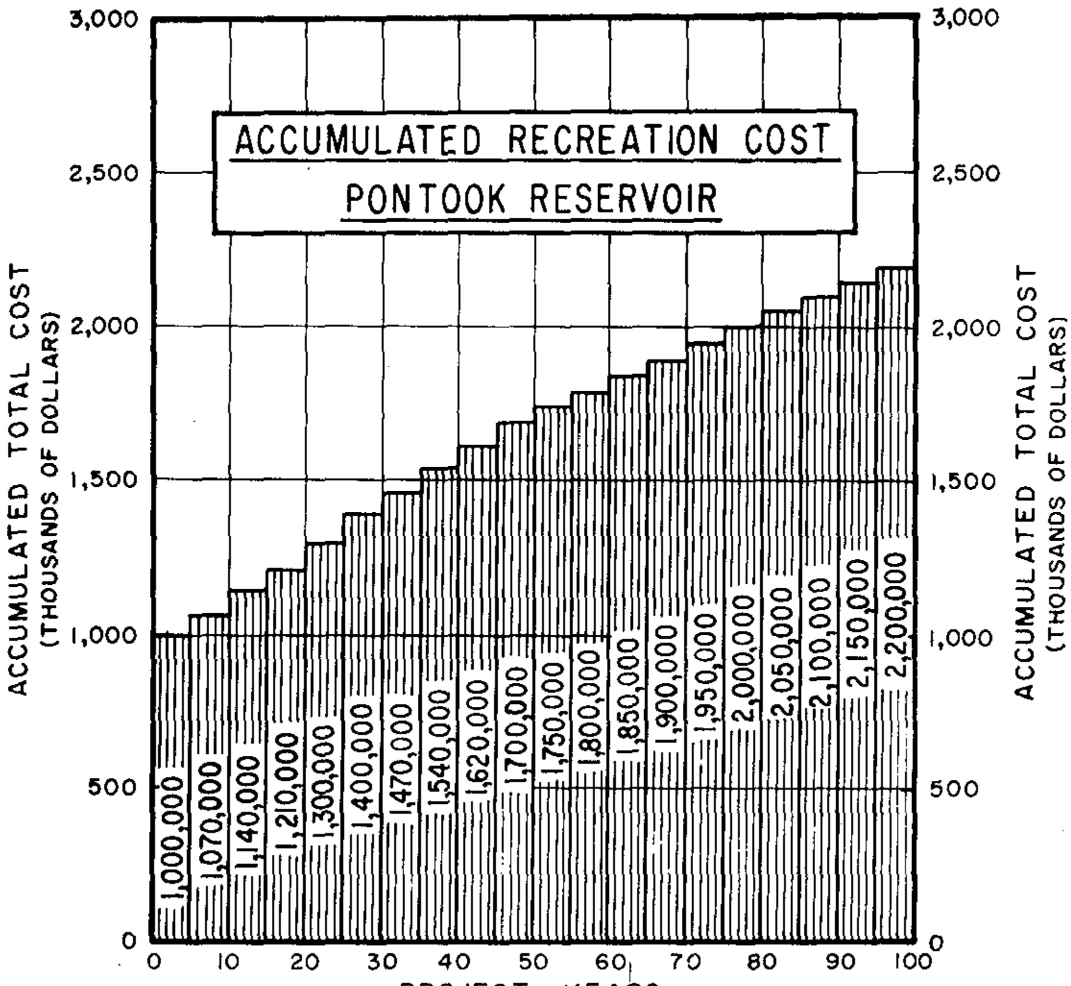


FIGURE 3

b. Benefits. Recreation benefits included in this evaluation are for uses of the developed recreational area and do not include visits to the project by sightseers, fishermen or hunters enjoying the natural resources of the project. A value of $1.50 per visitor-day has been chosen since the proposed Pontook Reservoir with a properly planned development is expected to offer a highly diversified water-based outdoor recreation resource unsurpassed in northern New England. With this unit value, annual benefits should reach $165,000 upon completion of the project and reach $606,000 annually by project year 100. Average annual equivalent benefits are $289,000 over the project life.

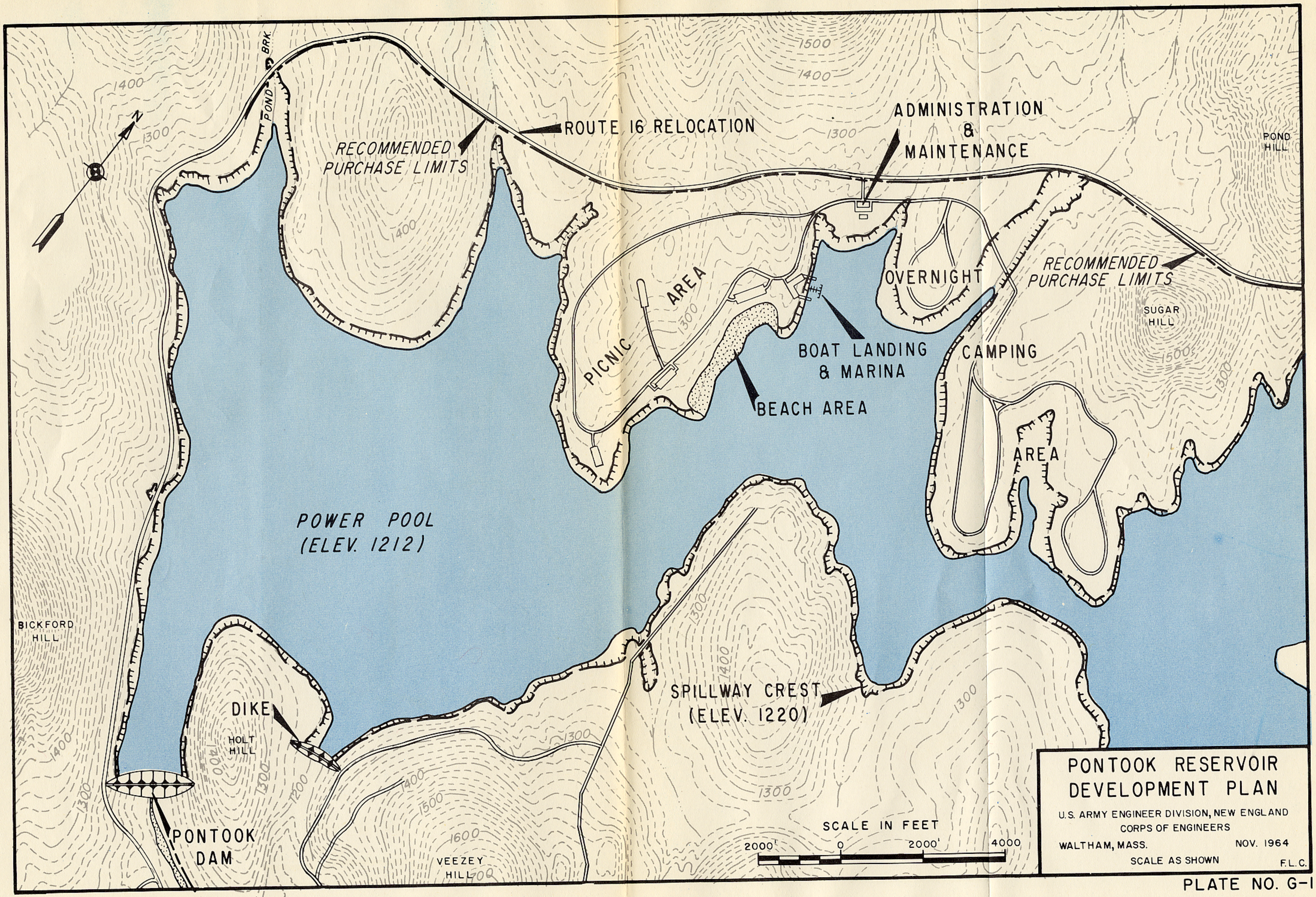

PONTOOK RESERVOIR
DEVELOPMENT PLAN
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
NOV. 1964
SCALE AS SHOWN
F.L.C.
SCALE IN FEET
2000'
0
2000'
4000
ROUTE 16 RELOCATION
RECOMMENDED PURCHASE LIMITS
ADMINISTRATION & MAINTENANCE
POND HILL
POND BRK
OVERNIGHT CAMPING AREA
PICNIC AREA
BOAT LANDING & MARINA
BEACH AREA
SUGAR HILL
POWER POOL (ELEV. 1212)
BICKFORD HILL
SPILLWAY CREST (ELEV. 1220)
DIKE
HOLT HILL
PONTOOK DAM
VEEZEY HILL
1200
1300
1400
1500
1600

PLATE NO. G-1

APPENDIX H

FISH AND WILDLIFE REPORT

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
59 TEMPLE PLACE
BOSTON, MASSACHUSETTS 02111

January 15, 1965

Division Engineer
U. S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

This letter constitutes our conservation and development report on the fish and wildlife resources associated with the Androscoggin River Basin project, New Hampshire and Maine. Initially the project consisted of two reservoirs, Pontook Reservoir in New Hampshire and Hale Reservoir in Maine. It is our understanding that you have determined that construction of the Hale Dam is infeasible and that you are not recommending its construction. Because of this determination we have omitted from this report a detailed discussion of the effects of the Hale Reservoir on the fish and wildlife resources. The discussion of this reservoir is limited to a brief, general summary of the influence it would have on the resources.

This report has been prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-666 inc.), in cooperation with the New Hampshire Fish and Game Department and the Maine Department of Inland Fisheries and Game. Authorization for your study is contained in the Resolution of the Senate Public Works Committee adopted November 21, 1955. The report has the concurrence of those agencies as indicated in their letters of December 1, 1964 and November 19, 1964, respectively.

If the Hale Dam and Reservoir were to be constructed on the Swift River three miles upstream from Mexico and Rumford as a multiple-purpose project for flood control, hydroelectric power, water supply, and recreation, both the moderate quality stream fishery and the wildlife resources would be adversely affected. A significant lake-type fishery would be created by the project.

Hunting opportunities for big game, upland game, and, to a lesser extent, waterfowl resources would be reduced. Some of the stream fishery losses could be recaptured downstream from the reregulating dam by oxygenating the discharge and providing public access for anglers to both banks of the river. By acquiring an additional 50 acres at the upper extremity of the reservoir and developing this area, together with an adjacent portion of the flood control pool, for waterfowl management, sufficient benefits would accrue to waterfowl to replace losses in that category as well as compensate for the big game and upland game losses. If at some future date the Hale Dam is reconsidered for construction, it will be necessary for us to prepare a detailed report on project effects at that time.

The dam site for the multiple-purpose Pontook Reservoir is located on the Androscoggin River about twelve miles upstream from Berlin, New Hampshire and about one mile downstream from the existing Pontook Dam. Project purposes are flood control, hydroelectric power, and recreation. When filled to the top of the flood pool, elevation 1220, the reservoir will inundate an area of 7,470 acres. An area of 6,500 acres will be inundated when the power pool is filled to its maximum level, elevation 1212. Four miles downstream from the new Pontook Dam will be a reregulating dam. The power house will be located immediately downstream from the main dam. A second and much smaller powerhouse will be located at the reregulating dam. Land will be acquired in fee title to elevation 1220 plus a horizontal strip up to 500 feet in width in those locations suitable for recreation.

Twenty-five miles of excellent cold-water stream fishery consisting of the segment of the Androscoggin River from the head of the reservoir, at the town of Errol to Berlin Airport (where pollution enters the river) and portions of tributary streams are in the area of project influence. This is principally a trout fishery and is one of the finest in New Hampshire, amounting to about half of the remaining fishery of such high quality. Under without-the-project conditions the stream fishery will support an estimated average annual fisherman use of 18,600 fisherman-days over the 100-year period of analysis. The 543-acre existing Pontook Reservoir supports a warm-water, lake-type fishery which is expected to provide an average annual utilization of 3,300 fisherman days over the same period.

Construction of the Pontook Reservoir and its reregulating reservoir will obliterate 17.5 miles of excellent quality stream fishery by inundation. Another 4.5 miles of the stream fishery downstream from the reregulating dam to Berlin Airport will be lost due to releases of water that will be deficient in oxygen.

Furthermore, the temperature of the downstream releases will be too cold for a stream fishery except during a brief period from midsummer to fall. The total with-the-project loss will amount to 14,800 fisherman-days, leaving only 3,800 fisherman-days of stream fishing; this remaining fishery being three miles of the Androscoggin River lying within the flood-pool segment of the reservoir.

The Pontook Reservoir will also inundate the existing reservoir. The new and much larger reservoir will provide a lake-type fishery (predominantly warm-water species) having an estimated annual utilization of 17,600 fisherman-days over the life of the project. While this represents an increase in reservoir fishing potential of 14,300 fisherman-days, it will not mitigate the loss of 14,800 stream fisherman-days, where the need far exceeds the opportunity and where there are no possibilities for creating such an excellent stream fishery in the future.

Without the project the reservoir area will produce annually an estimated 10,000 hunter-days of deer hunting, 1,800 of upland-game hunting, and 450 of waterfowl hunting. Fur-animal resources are expected to yield about 900 pelts annually without the project.

Construction of the project will eliminate approximately 6,000 acres of terrestrial wildlife habitat and a small acreage of good to excellent fur-animal habitat. Most important in the terrestrial habitat losses are 4,000 acres of excellent deer-wintering habitat. This type of habitat is critical to the survival of deer in this area. The elimination of this habitat will reduce the average annual big-game hunting opportunities to 1,600 hunter-days, a loss of 8,400 hunter-days. Upland-game hunting opportunities will be reduced to 300 hunter-days, representing a loss of 1,500 hunter-days annually with the project. The annual fur harvest is expected to be reduced by 50 percent.

The project will also eliminate 115 acres of excellent waterfowl habitat plus a larger acreage of lower value habitat. In its place will be more extensive but even poorer habitat. It is expected that 300 waterfowl hunter-days will be lost, leaving only 150 hunter-days.

As stated above, the enlarged warm-water reservoir fishery will not mitigate any of the exceptionally valuable cold-water stream fishery. There is no known way to mitigate the 11,700 fisherman days of stream fishery destroyed within the impoundments. The only opportunity to mitigate the stream fishery is in recapturing a portion of the fishery that is lost in that segment of the river downstream from the reregulating dam. This should be done by oxygenating the released waters and providing adequate public access to this segment of the river.

The released waters should have a dissolved oxygen content of at least six parts per million. A 100-foot wide strip of land along each bank of the river downstream from the reregulating dam to the Berlin Airport, a distance of four miles, should be acquired in fee title. In addition, three one-acre graveled parking areas with boat ramps should be constructed as a project cost. Approximate locations are shown on plate I. One area on each side of the river should be constructed at the first site upstream from the Berlin Airport.

Approximately 100 acres of land would be required. It is estimated that the land would cost $10,000 and that the construction and annual maintenance costs of each parking lot would be $6,000 and $250, respectively.

Providing oxygenated water releases and public access to the river between the reregulating dam and Berlin would furnish 2,300 fisherman-days. Adding this to the 3,800 fisherman-days of with-the-project stream fishery makes 6,100 fisherman-days with mitigation measures, leaving an annual loss to the stream fishery of 12,500 fisherman-days.

In order to obtain maximum utilization of the reservoir fishery, nine one-acre graveled fisherman parking areas, seven with launching ramps, approximate locations as shown on plate I, should be constructed and maintained around the reservoir. The average cost of constructing each area is estimated to be $6,000. Maintenance costs are estimated at $250 annually for each area. The provision of these facilities would increase the average annual fisherman use of the reservoir by 4,200 fisherman-days, none of which would mitigate the lost stream fishery. All fisherman access facilities at the reservoir and downstream should be maintained as a part of the over-all project costs.

Fisn screens should be installed around the penstock intakes to reduce fish losses. The screens should consist of a grating having clear space between bars of one inch.

Fish passage facilities for anadromous fish would not be needed until downstream pollution is eliminated, fish passage over downstream barriers is provided, and spawning potential upstream from Pontook Dam is determined. However, it is possible that the reservoir may provide a better cold-water fishery than now anticipated. In this case, the elimination of pollution from Berlin downstream could open many miles of downstream spawning grounds for trout or land-locked salmon in the reservoir. Because of the possibility of restoring anadromous fish or landlocked salmon or trout, project plans should provide for future construction of fish-passage facilities at both the main dam and the reregulating dam.

The mitigation of the lost deer-wintering habitat should consist of the acquisition, initial development, the operation and maintenance of 11,800 acres of land at Federal cost. Location of the lands needed is shown on plate I. Portions of the land adjacent to the reservoir may be used for general recreation during the summer without serious conflict with wildlife needs. The New Hampshire Fish and Game Department will undertake the initial development and operation and maintenance work. That agency should be reimbursed with Federal funds, chargeable to the project, for the cost of accomplishing this work. The estimated cost of land is $540,000, development costs are estimated at $50,000, and estimated annual operation and maintenance costs are $5,000. The acquisition and development of the wildlife mitigation lands would increase the big-game hunting opportunities to 9,650 hunter-days annually, leaving a net loss of 350 hunter-days in this category. There is no practical way to mitigate the lost upland-game resource.

In order to replace the waterfowl losses, a marsh of about 110 acres should be developed and maintained on Mollidgewock Brook within the area acquired for the mitigation of deer losses. This development would require a low dam that would impound water to a maximum depth of three feet. The structure should be provided with a water-control structure to permit water-level manipulations, and an access road is also required. It is estimated that this marsh, under proper management, would provide 1,000 waterfowl hunter-days annually. This amounts to 550 more hunter-days than under without-the-project conditions. This increase would compensate for the lost upland-game hunting opportunities. The estimated cost of constructing the impoundment and access road is $49,000 and annual operation and maintenance costs are estimated at $2,500. The New Hampshire Fish and Game Department will undertake the operation and maintenance work. That agency should be reimbursed with Federal funds, chargeable to the project, for the cost of accomplishing this work.

It is recommended--

1. That provision be made for mechanical aeration of releases from the reregulating dam to assure dissolved oxygen content of six parts per million in the stream segment downstream to Berlin, New Hampshire.

2. That fish screens having one-inch wide openings be installed around the penstock intakes.

3. That public access to the river between the reregulating dam and the Berlin Airport be acquired in fee title in the form of 100-foot strips along each bank of the river.

4. That three one-acre graveled parking areas with boat ramps be constructed and maintained along the river downstream from the reregulating dam, as a project cost.

5. That nine one-acre graveled parking areas, with boat ramps at seven, as shown on plate I, be constructed and maintained, as a project cost, around the reservoir for fisherman use; space needed for non-angler use would be additional.

6. That project plans provide for future construction of fish passage facilities at both the reregulating dam and the main dam at such time as this Bureau and the New Hampshire Fish and Game Department shall jointly agree that these facilities would substantially benefit a restored anadromous fish run or the spawning of important resident species.

7. That 11,800 acres, as shown on plate I as deer habitat replacement lands be acquired in fee title and initially developed as a project cost.

8. That a shallow marsh on Mollidgewock Brook of approximately 110 acres (indicated on plate I for waterfowl loss mitigation), together with necessary access road and water control facility, be constructed as a project cost.

9. That the New Hampshire Fish and Game Department be reimbursed with Federal funds, chargeable to the project, for costs involved in the initial development of the big-game mitigation lands, and for the annual operation and maintenance costs applicable to these lands and to the Mollidgewock Brook marsh.

10. That operation and maintenance costs related to mitigation measures be treated in the same manner as the construction or capital costs of mitigation measures and included as part of the overall project costs.

11. That the reimbursement of operation and maintenance costs related to mitigation measures be determined in accordance with current policy as described in H.R. 9032, 88th Congress proposed Federal Water Project Recreation Act.

12. That all lands and water areas of the Pontook Reservoir project except those areas which may be reserved for intensive development of general recreation or for safety, efficient operation, or protection of public property, be made available for administration by the New Hampshire Fish and Game

Department under a General Plan for Fish and Wildlife Management in accordance with provisions of the Fish and Wildlife Coordination Act.

13. That your report provide for the early cooperative development of a preliminary Master Land Use Plan with this Bureau and other interested agencies which will include (a) reservoir zoning, (b) land clearing, (c) fishing access site, (d) recreation sites, (e) road relocations.

14. That additional detailed studies of fish and wildlife resources be conducted, as necessary, after the project is authorized in accordance with the Fish and Wildlife Coordination Act; and that such reasonable modifications be made in the authorized project facilities as may be agreed upon by the Director of the Bureau of Sport Fisheries and Wildlife, the Chief of Engineers, and the Director of the New Hampshire Fish and Game Department for the conservation and development of these resources.

Sincerely yours,

Fred L. Jacobson

Fred L. Jacobson
Acting Regional Director

PREFACE

This report is an analysis of the Androscoggin River Basin project in relation to fish and wildlife resources. Initially two reservoirs were included in the project plans; the Pontook Reservoir in New Hampshire and the Hale Reservoir in Maine. The latter reservoir was found to be economically infeasible and its construction will not be recommended by the Corps of Engineers at this time. This report has been prepared in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-666 inc.). Effects which the project is expected to have on fish and wildlife resources are set forth. Measures which should be incorporated in project plans to mitigate or compensate for fish and wildlife losses are described.

Findings and conclusions are based upon engineering data made available by the U. S. Army Corps of Engineers, New England Division.

SUBSTANTIATING REPORT

INTRODUCTION

1. We understand that the multiple-purpose Pontook Dam and Reservoir is designed for flood control, hydroelectric power production, and recreation. This reservoir will replace the small existing Pontook Reservoir. The project located on the Androscoggin River upstream from Berlin, New Hampshire, consists of a main dam and a reregulating dam.

DESCRIPTION OF THE AREA

2. The Androscoggin River is formed by the junction of the Magalloway and Rapid Rivers at Errol Dam on Umbagog Lake, New Hampshire. It is one of the larger New England rivers carrying waters from Maine, New Hampshire, and Canada. The drainage area upstream from the dam site totals 1,215 square miles. From its head, the Androscoggin River flows south to the village of Gorham. Here it turns eastward into Maine. Upstream from Livermore Falls, Maine, the river turns southward again to its outlet in Merrymeeting Bay, eight miles downstream from the head of tidewater at Brunswick, Maine. The total length of the river is about 169 miles. Between Umbagog Lake and tidewater at Brunswick the river falls a total of 1,245 feet in 161 miles, an average slope of about 7.7 feet per mile. Steep gradients are found at Berlin, New Hampshire, where the river drops some 240 feet in 2.5 miles, and at Rumford, Maine, where there is a fall of 180 feet in 1.6 miles. In the 18.0 miles between the existing Errol Dam downstream to the site of the new Pontook Dam the river drops 100 feet.

3. As measured at the Errol, New Hampshire, gauging station, the average annual stream flow is 1,890 cubic feet per second (adjusted 53-year records). Maximum instantaneous stream flow data are not available prior to December 9, 1943. The maximum daily flow recorded since that date is 15,700 cfs. No data are available on the minimum daily discharge because leakage occurs when the gates in the Errol Dam are closed.

4. An agreement between the Union Water Power Company that operates the Errol Reservoir and several downstream users provides, insofar as possible, for a minimum flow of 1550 cfs at Berlin. Since 1929, flows below the desired minimum have occurred occasionally.

5. Several small tributaries join the Androscoggin River within the project area. Mollidgewock, Smokey Camp, Island, Bear, Bog, Sessions, and Robbin's Brooks and Chickwolnepy Stream are the most important of these.

6. The entire Androscoggin system is noted for the multitude of water use projects. Water levels in virtually all of the large lakes upstream from the Pontook Dam site have been raised by outlet dams designed for water storage. The existing Reservoir provides log storage. There are eight small existing power development projects on the Androscoggin River in the vicinity of the project. Four of these privately-owned dams are located at Berlin, New Hampshire and four downstream from Berlin.

7. The general topography on the upper Androscoggin consists of complex mountainous and hilly uplands dissected by many narrow valleys. Flats of various widths border the river and larger tributaries. Elevations range between 1,000 and 2,000 feet. Hillsides are steep and rocky. The extremely variable soils of the valleys and lowlands, largely outwash deposits of sand, gravel, silt and clay, are generally unsuited to intensive agricultural use.

8. Most of the project area is forested. Relatively pure stands of conifers account for about half of the total woodland; mixed hardwoods and conifers, hardwoods, and alder swamp comprise the remainder. All stages of forest succession are represented as the result of lumbering and pulpwood operations. Hayfields and farmlands (often abandoned or fallow), open swamps, and water account for the bulk of the unforested acreage.

9. The humid, continental climate is characterized by short, cool summers, long, cold winters, and frequent but short periods of heavy precipitation. Average annual precipitation is about 38 inches distributed rather uniformly throughout the year. Mean monthly temperatures at Berlin, New Hampshire vary from 66° F. in Julv to 15° f. in January. Extremes range from highs above 90° F. to lows of minus 40° F.

10. The upper Androscoggin Basin is sparsely populated. Coos County in which the project is located has a total population of 37,000. Berlin, with a population of about 18,000, is the principal community located near the dam site and the largest town in the upper basin. Extensive forest lands have fostered the development of lumbering activities which are of primary importance here. Production of pulp, paper, and allied products constitutes the principal industrial activity. Agricultural activities are of limited economic importance in this area. The sparse population and the outstanding scenic features of the project area make it one of high esthetic value.

11. The Berlin National Fish Hatchery, Milan Hill State Park, and sections of the White Mountain National Forest are located in the general vicinity of the project.

PLAN OF DEVELOPMENT

Engineering Features

12. The dam site is located in New Hampshire on the Androscoggin River about twelve miles upstream from Berlin and about one mile downstream from the existing Pontook Dam. The existing low dam, now holding a pool at about elevation 1158, will be inundated. The assumed project life is 100 years. The minimum power pool at elevation 1182 will flood 2,950 acres. The maximum power pool at elevation 1212 will have a surface area of 6,500 acres, a maximum depth of 88 feet at the dam, and will inundate about 15 miles of the Androscoggin River, (including the existing reservoir) to a point 1/2 mile upstream from Mollidgewock Brook. The maximum flood control pool at elevation 1220 will cover 7,470 acres and extend upstream to the vicinity of Errol, New Hampshire. Table I summarizes the pertinent reservoir data. All trees will be removed from the reservoir up to elevation 1212. We understand that above the maximum flood pool, a 500-foot wide strip will be acquired in fee simple in portions of the project area, in accordance with recommendations of the Bureau of Outdoor Recreation. This strip will extend upstream to Mollidgewock Brook on the east and Pond Brook on the west side of the reservoir.

13. The dam will be of the rock-fill type, approximately 2,000 feet long, with a top width of 25 feet, and a maximum height of 115 feet. An intake tower will be located immediately upstream on the east abutment of the dam. Intakes will be protected by trash racks. Water velocity at these racks will be less than two feet per second. The spillway will be located on the east bank, and a powerhouse will be located on the east bank immediately downstream from the dam.

14. Outlet works will consist of penstocks, a flood control outlet, a log sluice conduit, and spillway. The two 32-foot diameter penstocks, with sill elevations of 1130 feet, will pass under the dam. This sill elevation will be 82 feet below the surface of the maximum power pool and six feet above streambed elevation. The gate controlled penstocks will terminate at the powerhouse. The gate house for the log sluice conduit will be attached to the east side of the intake tower, with the sill elevation of the conduit at elevation 1184.

15. Table 1. Pertinent data for Pontook Reservoir

Pool	Elev. (ft. m.s.l.)	Surf. Area (ac.)	Capacity (ac./ft.)	Shore-line Miles	Miles of Stream Inundated Main stem	Tributaries1/
Flood Control Pool	1220	7,470	238,000	56	18	15-1/2
Maximum Power Pool	1212	6,500	180,000	43	15	11
Minimum Power Pool	1182	2,950	39,000	31	11	7
Streambed at Dam	1124	---	----	--	--	--

16. A low downstream reregulating dam and reservoir will be constructed. We understand that the site for this dam is about four miles downstream from the site of the new Pontook Dam. A small power plant will be constructed at this dam to utilize the releases for power production. Pertinent data for reregulating dam are given in table 2.

17. Table 2. Pertinent data for the Pontook reregulating reservoir.

Pool	Elev. (ft. m.s.l.)	Surf. Area (ac.)	Capacity (ac./ft.)	Shore-line Miles	Miles of Stream Inundated Main Stem	Tributaries
Maximum Pool	1118	690	9,300	6.0	3.5	1.5
Minimum Pool	1112	530	5,200	5.5	3.5	1.5
Streambed at Dam	1084	---	-----	---	---	---

18. Operation

During the recreation season, the power pool of the Pontook Reservoir will be held close to the maximum elevation, normal daily fluctuations being less than one foot. The average annual fluctuation of the power pool will be about ten feet. It is expected that the maximum drawdown of about 28 feet will occur annually during the spring season, to be refilled with snow-melt run-off. Normally, power will be generated about 2.2 hours per day during late afternoon and morning periods of peak demand. When power is being generated, discharges from the Pontook Dam will be about 23,000 cfs. The remainder of the time the penstock gates will be closed, and the discharge due to leakage and seepage from Pontook Dam will be 75 cfs.

1/ This segment includes 5 miles of stream inundated by existing Pontook Reservoir.

19. It is expected that about half of the flood storage capacity will be used once in 5 to 10 years, and that the entire flood pool will be used in 35 to 40 years. Some flood storage will usually result from the spring runoff.

20. The reregulating dam will have a single-cycle maximum daily fluctuation of six feet. It will provide a continuous minimum downstream flow of 1675 cfs. The depth of the reregulating reservoir insures a continuous pool extending to the foot of the Pontook Dam. The peak-period operation for the Pontook Dam will result in violent water surges in the reregulating reservoir. When the penstocks are opened, there will be an extremely rapid rise in water levels of about six feet in the reregulating reservoir waters immediately downstream from the powerhouse. When this wave reaches a point midway in the reservoir, it will have subsided to a height of about two feet. When the surge reaches the reregulating dam, approximately 15 minutes after the penstocks are opened, the wave height will be less than a foot. Thereupon, an upstream resurge is anticipated.

21. Water releases from the Errol dam and the upstream storage will be used to stabilize the Pontook Power pool.

FISHERY SECTION

Without the Project

22. That segment of the Androscoggin River affected by the project from Errol to the Berlin airport supports both a warm and a cold-water fishery. The existing Pontook Reservoir, a shallow impoundment, having a maximum depth of about 15 feet, extends upstream to the mouth of Bog Brook and covers some 543 acres. It supports a warm-water fishery consisting of excellent populations of chain pickerel and brown bullhead. Yellow perch, pumpkinseed, suckers, and various species of minnows are found in small numbers. Fishing pressure, largely by local sportsmen, is light. The present average annual fisherman use in the existing Pontook Reservoir is estimated at 1,100 man-days. The 1951-52 creel census indicated that brown bullhead and chain pickerel accounted for 81 percent of the catch. Projected over the period of analysis the reservoir fishery will average 3,300 fisherman-days annually.

23. Within the area of project influence is an excellent cold-water stream fishery, one of the finest remaining in the State. Approximately nine miles of this fishery are found

in the Androscoggin River between the present Pontook Dam downstream to the Berlin airport, where pollutants enter the river. Upstream from the headwaters of the present reservoir, the stream fishery extends 11.5 miles on the main stem to elevation 1220 (town of Errol). A total of 4.5 miles of tributary stream fishery which also provide excellent fishing are included in the area of project influence below elevation 1212. Three miles of the tributary fishery are upstream and 1.5 miles are downstream from the present reservoir. Thus 20.5 miles of main stem stream fishery and 4.5 miles of tributary stream fishery lie within the area of project influence.

24. These waters support rainbow, brown, and brook trout, and a few landlocked salmon, species much prized by sportsmen. The wide fast-running stretches of the main stem above and below the existing reservoir represents about half of the remaining 50 miles of superlative cold-water stream fisheries in New Hampshire. The clear, clean riffles and pools are bordered by miles of unspoiled forest. The upper Connecticut River is the only other stream with comparable esthetic values and quality of fishing in the State. Dams and pollution have already destroyed most of the once abundant large-stream trout and salmon fisheries of New England.

25. The upper Androscoggin has spawning areas for resident fishes and natural reproduction provides an important segment of the angler catch. These same spawning areas are suitable for Atlantic salmon, an anadromous species long barred from the Androscoggin by dams and gross pollution beginning at Berlin and extending to the ocean. The State supplements the natural reproduction with regular releases of brook, rainbow, and brown trout and occasional releases of landlocked salmon.

26. Current stream-fishing pressure is moderate, a reflection of relative remoteness from population centers. An appreciable number of the anglers are either from distant points in the State or from other States. The 25 miles of cold-water stream fisheries within the area influenced by the project support a present fishing pressure of about 6,600 fisherman-days annually. Creel census data for cold-water fishing were gathered upstream and downstream from the existing Pontook Reservoir in 1951-52. It was found that trout constituted about 94 percent of the catch. Because of an expanding fishery management program, the fishing success is considerably better today.

27. It is estimated that over the period of analysis the excellent stream fishery will provide an average of 18,600 fisherman-days annually. This man-day utilization is

divided as follows: 3,800 within the flood storage pool (elevation 1212 to 1220), 11,700 between the reregulating dam and top of maximum power pool (elevation 1084 to 1212), and 3,100 downstream from the reregulating dam. The great esthetic value of the stream fishery cannot be measured by any known yardstick; it is both outstanding and irreplaceable.

28. With the Project

The small warm-water fishery in the existing shallow, 543-acre reservoir will be inundated by the new Pontook Reservoir having an area of 6,500 acres (maximum power pool) and a much greater depth. Initially, the large new Pontook Reservoir will support a substantial cold-water fishery. The much greater depth of this reservoir, as compared to that of the existing pool, will result in lower sub-surface water temperatures.

29. Based on the water level fluctuations predicted by the Corps of Engineers the Pontook Reservoir will permit a modest fishery management program involving releases of salmonoid fingerlings by the State. New Hampshire, however, could not afford continuing management of a put-and-take trout fishery since the stocking required for an acceptable catch rate would account for nearly half of the State's current hatchery production.

30. Experience indicates, moreover, that warm-water species will become dominant in the reservoir within a few years despite any practical management for cold-water species. A relatively stable two-story fishery would then be established. Warm-water species, principally chain pickerel, brown bullhead, and yellow perch would account for most of the fish population and the catch. The limited cold-water habitat would be determined by the depth and resulting area of the thermocline. Approximately 2,200 acres of the maximum power pool with waters less than 20 feet in depth would be productive. Future warm-water harvests would approximate present success (.74 fish per hour of effort). The catch of cold-water species would be dependent largely on the stocking rate.

31. The expanded lake-type fishery will provide an annual utilization of 17,600 fisherman-days (predominantly a warm-water fishery) over the life of the project. Although this represents an increase of 14,300 fisherman-days in lake-type fishing, it does not mitigate the loss of the stream fishery since the reservoir fishery is gained at the expense of a much superior and irreplaceable stream fishery.

32. Three miles of cold-water stream fisheries (main stem) above elevation 1212 (top of the maximum power pool) will occasionally be covered during floodwater storage. No reduction in the without-the-project fishery of 3,800 fisherman-days is expected in this stream segment.

33. A total of 17.5 miles of cold-water stream fishery will be inundated and destroyed by the Pontook Reservoir and the reregulating pool, resulting in an average loss of 11,700 fisherman-days annually of high quality stream fishery. Salmon and trout spawning areas within the power pool will be flooded and destroyed.

34. Unlike the new Pontook Reservoir, the reregulating reservoir will not provide a fishery. The violent daily or twice-daily water surges released into the reregulating reservoir as a result of peaking power production will be unsafe for fisherman utilization. Furthermore, powerful wave and current action will be damaging to all aquatic life, making it highly improbable that a fishery could be established regardless of fisherman safety considerations.

35. The releases from the reregulating reservoir will be too deficient in oxygen to maintain a significant stream fishery in the 4.5 miles downstream to Berlin airport. Furthermore, during the spring and early summer period the released waters will be too cold (less than 45°) to support a significant fishery at that time even though dissolved oxygen was adequate. The loss in this stream segment will amount to 3,100 fisherman-days annually.

36. The stream fishery under project conditions will be limited to 3,800 fisherman-days in that stream segment between the top of the power pool and the top of the flood-control pool. All the remaining high quality stream fishery amounting to 14,800 fisherman-days annually will be destroyed by the project. Furthermore, within the enlarged reservoir, streambed spawning areas for salmonoid species will be destroyed. Finally, a significant segment of the rare and irreplaceable aesthetic value of the wide, swift-flowing Androscoggin River will be lost.

WILDLIFE SECTION

37. Without the Project

Land use and cover types in the project area provide good big game and upland game habitat (table 3). Cultivated and cleared land is confined chiefly to the valleys; pure stands of conifers to the valleys and lower slopes.

Table 3. Cover and land use occurring within the Pontook and reregulating reservoir areas 1/

Type	Acreage	Percent
Forest	3,952	48
Swamp 2/	1,915	24
Water	1,023	13
Roads, building sites, development	160	2
Cultivated or cleared land	1,074	13
Totals	8,160	100

1/ Includes to el. 1220 (full flood pool) for the reservoir; to el. 1118 (maximum pool) for the reregulating pool.

2/ Includes forest swamp, alders, etc.

38. Virtually all of the wildlife species indigenous to central and northern New Hampshire are found in the area affected by the project flood pool and reregulating reservoir. Big game is the most important category of wildlife. Whitetail deer is the principal species but there are some black bears and a few moose. Bears are usually taken during the deer season, but the moose is a protected species. This is exceptionally good deer range containing vital wintering yards, essential for deer survival in these latitudes. These yards encompass some 4,000 acres of mature softwood stands, interspersed with hardwood browse species. The yards support a winter herd having a minimum population of 700 animals. During warmer seasons, this herd ranges over a wide area outside the general project area. The deer population has reached the carrying capacity of the winter range.

39. This herd, plus the annual increment of fawns, will yield an annual harvest of about 350 animals, and provide an estimated 10,000 man-days of hunting over the period of analysis. This represents comparatively heavy hunting pressure and is the result of good year-round deer habitat and adequate road access. Today about half the hunters are local sportsmen and it is expected that local hunters will comprise about the same proportion of the future hunter population.

40. Small numbers of snowshoe hares are found over most of the area. Hunting pressure is relatively heavy in the limited sectors where the hare is common or abundant. There is a

considerable acreage of good woodcock range. Breeding grounds and other seasonal habitats are available in the alder swamps and small openings. Ruffed grouse, subjected to moderate hunting pressure, are present in fair numbers. Upland-game hunting is pursued principally by local nimrods.

41. It is estimated that current hunting pressure for all upland-game species totals 600 man-days per year but heavier utilization by hunters is expected. The average annual utilization of the resource over the next hundred years is estimated at 1800 hunter-days.

42. Fur bearers include muskrat, otter, mink, bobcat, beaver, fisher, raccoon, red fox, weasel, marten, and skunk. Muskrat, mink, and otter provide most of the fur harvest. Beaver have an excellent but largely unrealized potential. Trapping pressure is variable but generally light. The present fur harvest yields about 400 muskrat pelts, 25 beaver, 10 mink, 5 otter, and a scattering of other species. There has been a gradual upward trend in fur prices leading to an increase in harvests. Over the project life the average annual fur harvest is expected to double that of today.

43. The project area contains one of the more important and extensive waterfowl areas in northern New Hampshire, a region with a paucity of good waterfowl habitat and huntable duck populations. Relatively small numbers of virtually all waterfowl species found in the Atlantic Flyway breed on or use the Pontook area during migration. Black ducks and wood ducks are most common. Meager census data indicate that current hunting pressure is light and largely dependent upon breeding success during the preceding season. The Pontook area presently supports, directly and indirectly, about 150 waterfowl hunter-days. Local hunters on the Pontook account for about two-thirds of this total while hunters in the more southerly regions account for the remaining 50 hunter-days. Annual waterfowl utilization over the period of analysis is estimated at 450 hunter days.

44. <u>With the Project</u>

Approximately 6,400 acres of terrestrial habitat will be totally lost in the two reservoirs due to inundation. About 760 additional acres above the power pool will be subjected to occasional flooding, but this will not significantly alter the habitat or affect the wildlife resources within the flood pool. Virtually all land use and cover types except upland forest are represented in the acreage to be inundated.

45. Major damages will be caused by the inundation of 4000 acres of deer wintering habitat. The wintering yards are vital during the critical cold-weather period. Displaced deer cannot move to other suitable wintering areas because the remaining yards are already fully utilized. With the project the wintering deer herd will be reduced to about 110 animals which will provide 1600 hunter-days a loss of 8400 hunter-days annually.

46. As in the case of the deer herd, the displaced upland-game populations cannot be superimposed on those existing outside the project area since upland game commonly fills the existing habitat to the limits of the carrying capacity. Furthermore, an important segment of upland-game habitat, notably alder thickets, openings, and field borders, is confined largely to the lowlands which will be inundated. Under with-the-project conditions the project area will provide about 300 man-days of upland-game hunting. This is an annual loss of 1500 hunter-days.

47. With the project a comparatively small acreage of good to excellent fur-animal habitat having relatively stable water levels will be inundated. In its place a much greater acreage of poor to fair habitat will be substituted. The latter will be characterized by daily water level fluctuations of about one foot. The net result will be a reduction in the average annual fur harvest amounting to 50 percent of that expected over the same period without the project.

48. The project will have more serious effects on waterfowl. A total of 115 acres of excellent waterfowl marsh and swamp having relatively stable water levels will be destroyed by inundation. A larger acreage of existing poorer habitat would also be flooded. The latter will be replaced by a more extensive but even poorer habitat created by the new impoundment. The new Pontook Reservoir, as contrasted to the existing reservoir, will be subject to both daily and seasonal water level fluctuations, a situation not conducive to nesting or to any significant production of aquatic waterfowl foods. The larger but relatively barren reservoir will attract fewer migrating and nesting birds than will the existing pool. With the project the man-days of waterfowl hunting will be reduced to 150, amounting to a loss of 300 hunter-days annually.

49. Fishery

There is no way to mitigate the 11,700 fisherman-days of superior quality stream fishery that will be inundated by the Pontook Reservoir and the reregulating reservoir. As was pointed out earlier, the increase in reservoir fishing will not mitigate the lost stream fishery. A portion of the 3,100 fisherman-days which will be lost downstream from the reregulating dam can be recaptured. This will require oxygenation of the released waters and adequate public access to the downstream segment of the river. Aeration and access must go hand in hand since one without the other will not produce a significant fishery. Unfortunately, there appears to be no practical way to further mitigate the loss by providing releases of warmer water early and late in the season.

50. Released waters should have a dissolved oxygen content of at least six parts per million. Downstream public access should be provided by acquiring in fee at project cost a 100-foot strip of land along each bank of the river from the reregulating dam to the Berlin airport, a distance of four miles. It is estimated that this would cost $10,000. Three one-acre graveled parking areas with boat ramp should be constructed and maintained as a project cost. Construction and annual maintenance costs for each facility are estimated to be $6,000 and $250, respectively. If public access is not provided, there is good reason to believe that eventual development of the stream bank for building sites will occur. Should this happen the State would neither manage nor stock this segment of the river. The approximate parking area locations are shown on plate I. At the first site upstream from Berlin airport an area should be constructed on each side of the river. It is possible that further planning may indicate the advisability of moving the site nearest the dam farther downstream for better access.

51. With provision for oxygenated water releases and public access as described above, the river downstream from the reregulating dam to Berlin airport will support 2,300 fisherman-days of stream fishing from mid-summer until fall. This, added to the undestroyed stream fishery in the flood control pool segment of the reservoir, makes 6,100 fisherman-days, leaving an annual loss of 12,500 fisherman-days of high quality stream fishery.

52. Nine one-acre graveled fisherman parking areas with a launching ramp at seven areas should be constructed and maintained around the Pontook Reservoir at the general locations shown on plate I. It is estimated that the cost of the parking areas will average $6,000 apiece and have an annual maintenance cost of $250 each. While some space should be provided initially at each area indicated, full development can be spread over several years as the demand warrants. Plans for maximum angler use should be included in the Master Land Use Plan for the reservoir. Providing parking areas and boat ramps for anglers will increase the average annual use of the reservoir by 4,200 fisherman-days, making a total annual use of 21,800 fisherman-days. Parking space required for fisherman use is in addition to that required for general recreation.

53. Fish screens or other protective barriers should be installed around the penstock intakes since the suction resulting from the 23,000 cfs flow will be appreciable. The screens should have a clear space between bars of one inch. Possibly the fish screen could be combined with the trash rack.

54. Fish passageways over the dams are not recommended at present. Restoration of anadromous fish in the Androscoggin is dependent on control of the gross pollution found between Berlin and the sea and on the installation of fish ladders at the many downstream dams and Rumford Falls. Waters above the Pontook project are also dammed and it is doubtful if the upstream spawning potential for sea-run salmon would justify a fishway at the Pontook dams. There is a possibility, however, that a fishway for trout and landlocked salmon will be needed in the future. Post-project studies may reveal a better cold-water fishery in the reservoir than is anticipated. In such case, pollution control in and below Berlin could open many miles of downstream spawning grounds for trout or landlocked salmon in the reservoir. For these reasons, project plans should provide for the future construction of fish passage facilities at both the main dam and the reregulating dam.

55. Wildlife

Deer wintering yard losses should be mitigated by the acquisition, development and maintenance of 11,800 acres of land as shown on plate I. Most of these lands are adjacent to the reservoir.

General recreational use of part of the area during the summer would not seriously conflict with the wildlife needs. Careful planning would eliminate any major conflicts of interest whereby camp sites might be developed in deer yards.

56. The discrepancy between acreage of deer yards flooded and acreage of land required for mitigation is attributable to the fact that lands available for purchase are either uplands of little current value as wintering habitat or they are remnants of existing wintering yards which will be flooded by the project. The uplands are not suitable yarding areas at present and the deer-carrying capacity of existing yards has been reached. Thus, neither the uplands in their present state nor the remnants of existing yards can support those deer forced out of the reservoir area. Consequently, a greater acreage of less desirable land must be acquired and developed in order to mitigate the smaller acreage of excellent deer yards.

57. Development procedures would include selective cuttings, seedings, and perhaps fencing. Details should be worked out at a later date with the New Hampshire Fish and Game Department. Following development, which will require 20 to 40 years, it is expected that the project will produce an average of 9,650 hunter-days annually, leaving a net loss of 350 days of deer hunting. Mitigation of the lost big-game resource is not expected to significantly affect the upland-game resource. It is estimated that land acquisition costs for big-game mitigation will amount to $540,000. Development costs and annual operation and maintenance costs are estimated at $50,000 and $5,000, respectively. The New Hampshire Fish and Game Department will undertake the work of development, operation, and maintenance and should be reimbursed for the cost of this work. Reimbursement should be a Federal project cost.

58. Waterfowl hunting losses will require mitigation. The Mollidgewock Brook area (which is included in lands that would be acquired for deer mitigation) contains potential waterfowl habitat. Waterfowl losses can, therefore, be mitigated by the construction of a shallow marsh on Mollidgewock Brook. The marsh should have an area of about 110 acres when filled, and range up to three feet in depth. A low dam would be required. This structure should include a water-control facility whereby the impoundment can be drained or held at any intermediate level. The developed waterfowl marsh would replace the existing habitat that will be inundated. The new marsh would produce some ducks, as does the present habitat. It would also furnish food for migrating birds, prolonging their stay, and providing an estimated 1,000 waterfowl hunter-days annually. The increase of 550 hunter-days over the without-the-project figure will compensate for the lost upland-game hunting opportunities.

59. The estimated construction cost for the low dam and access road is $49,000; annual operation and maintenance costs are estimated at $2,500. Operation and maintenance work will be undertaken by the New Hampshire Fish and Game Department. The Department should be reimbursed for the cost of the work with Federal funds as a project cost.

60. The lands and waters within the Pontook Reservoir project except those areas which may be reserved for intensive development of general recreation or for safety, efficient operation, or protection of public property, should be made available for administration by the New Hampshire Fish and Game Department under a General Plan for Fish and Wildlife Management in accordance with provisions of the Fish and Wildlife Coordination Act.

61. Table 4 summarizes the fishery aspects of the project without and with mitigation.

Table 4. Summary of the project effects on fisherman use without mitigation, with mitigation, and with reservoir access and parking facilities.

	Fisherman-days				
Type of fishery	(a) Without project	(b) With project	(c) With Mitigation 1/	(d) With reservoir access & parking facilities	(e) Difference (d)-(a) & (c)-(a)
Reservoir	3,300	17,600	-----	21,800	18,500
Stream	18,600	3,800	6,100	----	-12,500

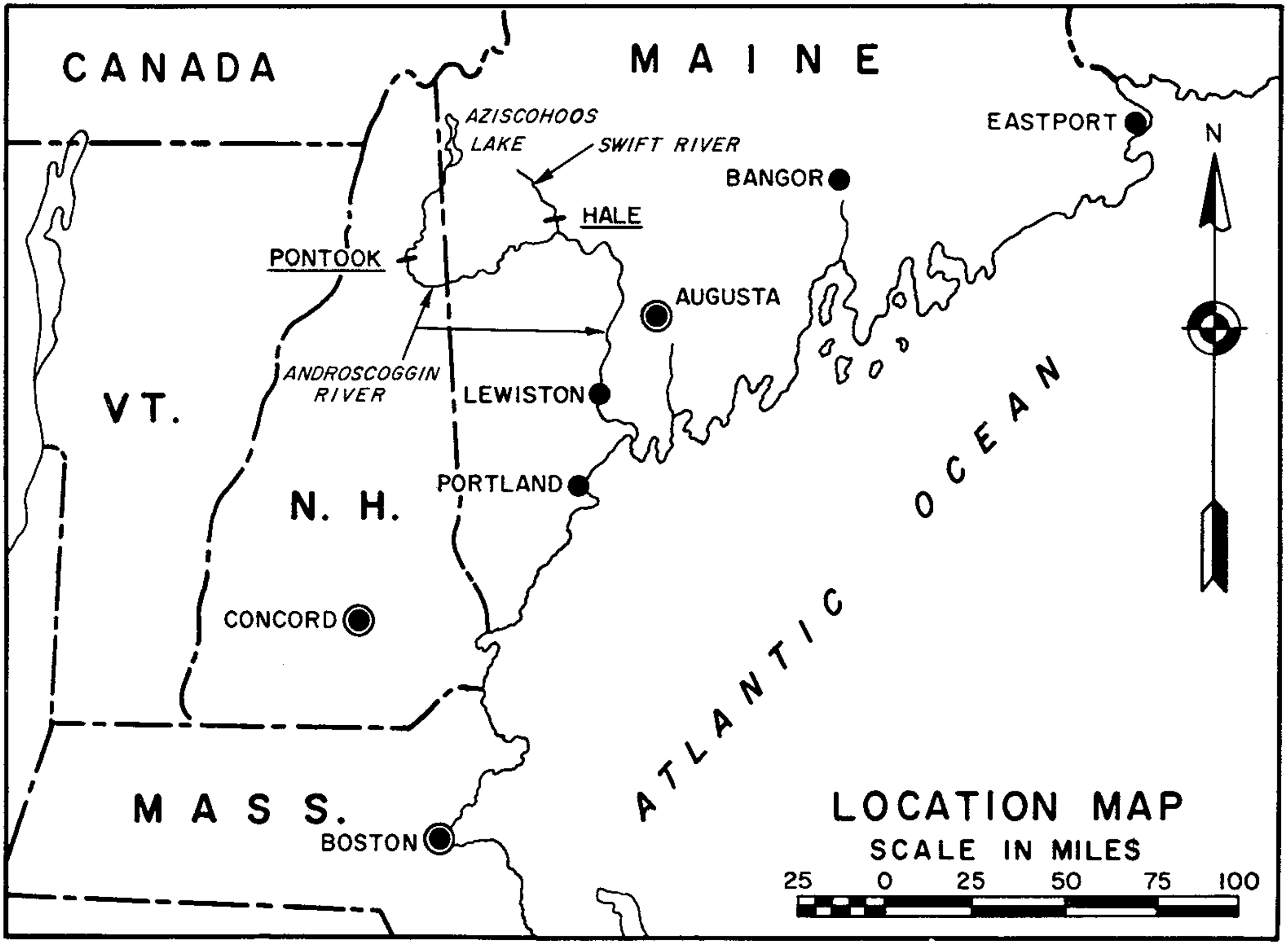
1/ Oxygenating releases from reregulating dam (6 ppm), and parking areas and access to downstream river banks.

62. Table 5 summarizes the wildlife aspects of the project without and with mitigation.

Table 5. Summary of the project effects on hunter use without mitigation and with mitigation.

	Hunter-days			
Wildlife category	Without project	With Project	With mitigation	Difference (c)-(a)
Big game	10,000	1,600	9,650	-350
Upland game	1,800	300	300	-1,500
Waterfowl	450	150	1,000	550 1/

1/ The additional waterfowl hunter-days will compensate the lost upland game resources.


CANADA
MAINE
AZISCOHOOS
LAKE
SWIFT RIVER
EASTPORT
N
BANGOR
HALE
PONTOOK
AUGUSTA
ANDROSCOGGIN
RIVER
LEWISTON
VT.
PORTLAND
N. H.
ATLANTIC OCEAN
CONCORD
MASS.
BOSTON
LOCATION MAP
SCALE IN MILES
25 0 25 50 75 100

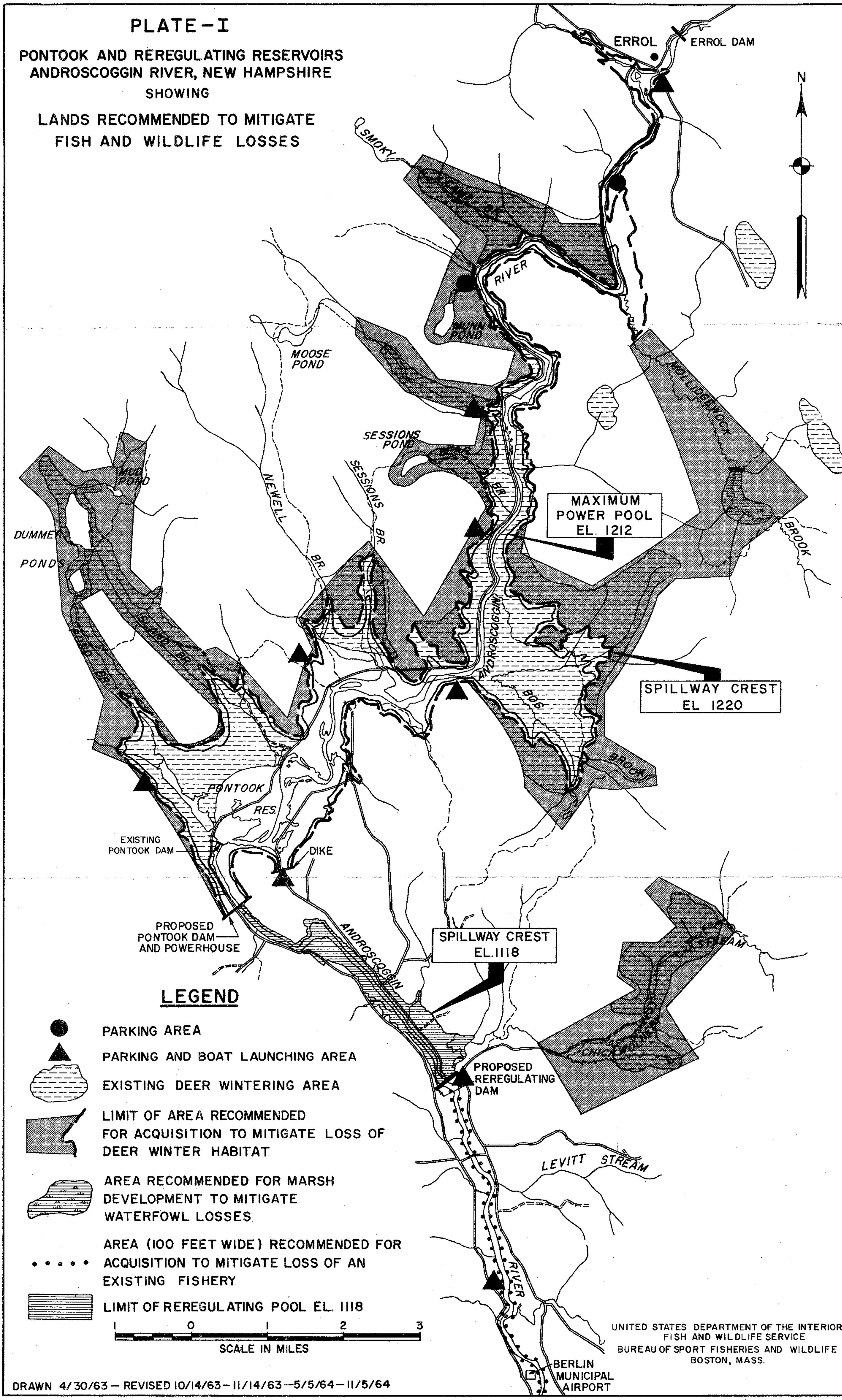


PLATE-I

PONTOOK AND REREGULATING RESERVOIRS
ANDROSCOGGIN RIVER, NEW HAMPSHIRE
SHOWING
LANDS RECOMMENDED TO MITIGATE
FISH AND WILDLIFE LOSSES

[illegible]
[illegible]

[illegible]
[illegible]

[illegible]
CHIEF ENGINEER

KENNETH W. HODGDON
CHIEF, GAME DIVISION

STEPHEN E. POWELL
ASST. CHIEF, GAME DIVISION

[illegible]
[illegible]

[illegible]
SUPT. OF HATCHERIES

WILLIAM C. MINCHER
DIRECTOR, INFORMATION AND EDUCATION

MAYNARD F. MARSH
CHIEF WARDEN

WINIFRED E. CLARK
SECRETARY TO COMMISSIONER

DEPARTMENT OF

Inland Fisheries and Game

RONALD T. SPEERS, COMMISSIONER
GEORGE W. BUCKNAM, DEPUTY COMMISSIONER
AUGUSTA, MAINE 04330

River Basin Studies
Adm.
Clerk-Steno (M) (M)
Files

November 19, 1964

Mr. Earl T. Walker
Acting Regional Supervisor
Branch of River Basin Studies
59 Temple Place
Boston, Mass. 02111

Dear Mr. Walker,

We have reviewed your draft of your conservation and development report on the fish and wildlife resources associated with the Androscoggin River Basin Project in New Hampshire and Maine.

Inasmuch as the Hale Reservoir has been deleted from consideration, and since the Pontook Area is the only other one involved, and that is entirely in New Hampshire, we find that there is nothing in the report of concern to the State of Maine, and I therefore, approve the report as written.

Should there be any changes or plans for this Basin in the future, I would be pleased to be informed.

Yours very truly,

Ronald T. Speers

Ronald T. Speers,
Commissioner

RTS:fsm

STATE OF NEW HAMPSHIRE
FISH AND GAME DEPARTMENT
34 BRIDGE STREET,
CONCORD
03301

COMMISSIONERS

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HAROLD E. FRENCH SUNCOOK
MICHAEL J. KEANE MANCHESTER
GERARD L. MORIN LACONIA
JOHN W. SARGENT GEORGES MILLS

ADDRESS ALL CORRESPONDENCE TO
... G. CARPENTER, 2ND, DIRECTOR

December 1, 1964

Mr. Earl T. Walker
Acting Regional Supervisor
Branch of River Basin Studies
Bureau of Sport Fisheries and Wildlife
59 Temple Place
Boston, Massachusetts 02111

Dear Mr. Walker:

This acknowledges receipt of the reviewed drafts relative to the conservation and development report on the fish and wildlife resources associated with the Androscoggin River basin project.

While we agree with the report as a whole, we have certain minor corrections to suggest.

On page 3, paragraph 2 the report points out that there will be an oxygen deficiency in the stream below the re-regulating dam resulting in a loss of 14,800 fisherman-days, leaving only 3800 fisherman-days of fishing. We believe that if an oxygen deficiency for salmonoids develops in a stream due to an oxygen deficiency in the reservoir above it there could be no salmonoid fish either in the stream or the reservoir above. If our reasoning is correct here, paragraph 2, page 5 would also have to be adjusted.

On page 5, paragraph 4 the report calls for 2"x2" mesh screens. We find it difficult to see how that size screen could reduce fish losses to any extent.

Page 10, No. 33 in the substantiating portion of the report should indicate that the destruction of salmonoid spawning areas would also include that of trout.

No. 35, page 10 - we wish to point out again that if there is an oxygen deficiency at the re-regulating dam, then the same will hold true below the thermocline in the main pool which would consequently rule out any salmonoid fishing there.

No. 53 on page 17 again talks about a 2" x 2" mesh screen which seems impractical to us.

On page 18, No. 54, line 4 the word "several" should be changed to "20 to 40."

We also wish to point out that the maps showing the proposed acquisition of existing deer yards are not inclusive enough - they should include the entire yarding area.

Sincerely yours,

Hilbert R. Ziegler

for Ralph G. Carpenter, 2nd
Director

RGC:eem

APPENDIX I

OTHER PROJECTS STUDIED

FOREWORD

This appendix presents features of preliminary design and estimates of cost for water resource development projects studied for the Androscoggin River basin but not recommended since they were not economically justified at this time. Annual costs and benefits are based on the previous interest rate of 3.0 percent. Use of the current interest rate of 3-1/8 percent would not significantly change the amounts or the benefit-cost ratios. The appendix is divided into two parts:

Part I - Dams and Reservoirs

Part II - Local Flood Protection Projects

APPENDIX I

OTHER PROJECTS STUDIED

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TABLES

APPENDIX I

PART I - DAMS AND RESERVOIRS

1. INTRODUCTION

Over 50 sites were considered for possible flood control and multiple-purpose dams and reservoirs. Of these, over 20 were eliminated early in the preliminary investigation because the benefits creditable were obviously insufficient to warrant additional studies. About half of the remaining 30 sites were considered in a prior survey report of 1938 and in the New England-New York Inter-Agency Committee report of 1955. By updating and using the maximum value assigned to flood control storage per acre-foot from the latter report, it was possible to determine which reservoir sites had sufficient economic justification to warrant a more detailed study. The storage value for any site was based on a hydrologic analysis of the flood potential of the basin; the existing reservoir storage in the basin; newly acquired flood damage data; and an assumed flood control storage of at least 6 inches of runoff from the intercepted drainage area. Based on preliminary estimated costs and economic data compiled for the 30 remaining reservoir sites selected for investigation, it was found that 11 sites were worthy of detailed study. Of these, the Pontook project was found economically justified and is further described elsewhere in this report. In evaluating the various projects, consideration was given to including facilities for hydroelectric power generation, water supply, recreation, and fish and wildlife enhancement. The following paragraphs describe the reservoir projects studied in some detail but not recommended. The Hale and Ellis Dams and Reservoirs were studied in more detail since these projects showed the most promise of being economically justified. A summary of pertinent dam and reservoir data is given in Table I-1 at the end of this appendix.

2. HALE PROJECT

a. General. Two plans were considered -- one for flood control only, the second for multiple-purpose flood control, power, and recreation. The latter provided the higher benefit-cost ratio and is described in the following paragraphs. Pertinent data for both plans are shown in Table I-1.

b. Main Dam and Reservoir.

(1) Description.

(a) Dam. The Hale damsite is located on the Swift River, approximately 2 miles above its mouth, in the town of Mexico, Maine. The dam, for multiple-purpose use, would be of rolled earth-fill, approximately 2,800 feet long, with a maximum height of 255 feet above the river bottom, and a top elevation of 784 feet above mean sea level. A chute spillway with a concrete ogee weir, 220 feet long and crest at elevation 763, would be located in the west abutment. A powerhouse would be located at the downstream toe of the dam, with a penstock intake works, containing an 18-foot by 16-foot bulkhead gate, at the upstream toe. A 13.5-foot diameter steel-lined concrete conduit would lead from the intake works to immediately above the powerhouse where it would split into two $8\frac{1}{2}$-foot penstocks and one 10-foot diameter conduit to the power plant. The $8\frac{1}{2}$-foot penstocks would be connected to two 21,000 horsepower Francis turbines. The 10-foot conduit would be used to discharge flood control storage at a rate equal to bankfull capacity of the river.

(b) Reservoir. The reservoir at spillway crest elevation 763 would be approximately $8\frac{1}{2}$ miles long, have a surface area of 3,800 acres, and a gross capacity of 332,000 acre-feet. The reservoir would provide storage of 47,400 acre-feet for flood control purposes between elevation 763 and 750, and 96,600 acre-feet for power purposes between elevation 750 and 714. A total gross head of 250 feet would be developed between a power pool elevation of 750 and a tailwater elevation of 500 at the powerhouse. Generating facilities for 33,750 kilowatts, in two units, would be installed in the powerhouse. The plant would produce about 31.0 million kilowatt-hours annually at a capacity factor of about 9 percent. Sufficient flood control storage would be provided in the reservoir to store 8 inches of runoff from the tributary drainage area of 111 square miles.

(2) Recreation. Land and water areas in and adjacent to the reservoir would be developed for recreational activities and wildlife conservation. Initial facilities would provide for swimming, picnicking, camping, boating, hunting, fishing, and other water related uses.

c. Reregulating Dam and Pool.

(1) Description.

(a) Dam. Since there would be a need for control of the high releases from the power house, a reregulating dam would be provided about one mile downstream of the main dam. The structure would have an overall length of approximately 1,580 feet of which 190 feet is a fixed-crest concrete spillway, and the remainder rolled earth fill. The top of the dam would be at elevation 500 and have a maximum height of 52 feet. The crest of the spillway would be at elevation 486. A 24-foot wide public roadway would be provided on top of the dam with a steel girder bridge spanning the spillway.

(b) Pool. The pool at spillway crest elevation 486 would have a surface area of 40 acres, and a gross capacity of 610 acre-feet. A low flow discharge of not less than the present minimum flow on the river would be provided through an ungated 42-inch diameter opening in the spillway in conjunction with a 12-inch diameter conduit through the embankment in the river bed.

No improvements for the development of recreational facilities would be provided for the pool area.

d. Project Cost. The total cost of the multiple-purpose project is estimated to be $31.1 million with annual charges of $1,193,000. Benefits would total $912,000, consisting of $183,000 for flood control, $704,000 for power, and $25,000 for recreation, giving a benefit-cost ratio of 0.8 to 1.

3. MOOSE RIVER DAM AND RESERVOIR

The dam site is located on the Moose River about 3-3/4 miles above its confluence with the Androscoggin in the town of Gorham, New Hampshire. The project, for flood control only, would require a rolled earth dam approximately 720 feet long, a maximum height of 120 feet, and top at elevation 1,250 feet above mean sea level. The dam would impound 8,500 acre-feet of flood control storage to control 8 inches of runoff from the tributary drainage area of 20 square miles. The spillway crest would be at elevation 1,231. The dam site is located within a narrow rock gorge. A railroad which follows the river through the reservoir area would require relocation. Modifications required in the project to include hydroelectric power would include an increase in the height of the dam to elevation 1,260 and crest of spillway to elevation 1,240. The reservoir would provide a storage of 8,500 acre-feet for flood control and 2,900 acre-feet for power purposes. A gross head of 72 feet could be developed between a pool elevation of 1,202 and a tailwater elevation of 1,130. Generating facilities for 1,500 kilowatts would be installed in the powerhouse located at the downstream toe of the dam. The plant would produce about 1.3 million kilowatt-hours annually at a capacity factor of about 10 percent. The total cost of the multiple-purpose project is estimated to be $3.6 million with a benefit-cost ratio of 0.7 to 1. The total cost of the project for flood control alone is estimated to be $1.8 million with a benefit-cost ratio of 0.6 to 1. There is no expressed need at this time for water supply or water quality storage features.

4. PEABODY RIVER DAM AND RESERVOIR

The dam site is on the Peabody River, approximately 2 miles above its mouth in the town of Gorham, New Hampshire. The project constructed for flood control alone would consist of a rolled earth dam approximately 2,360 feet long and 160 feet high with top at elevation 1,081, above mean sea level; a concrete spillway 229 feet long with crest at elevation 1,062; and gated outlet works. The reservoir at spillway crest would be 1½ miles long, have a surface area of about 370 acres, and a flood control storage capacity of 18,500 acre-feet, equivalent to about 8 inches of runoff from the tributary drainage area of 43 square miles. About 2½ miles of Route 16 would require relocation to higher ground along the perimeter of the reservoir. The generation of hydroelectric power was also considered for the project. Such a development would require a dam with top at elevation 1,119, a spillway with crest at 1,100, and reservoir storage of 18,500 acre-feet for flood control purposes, and 16,500 acre-feet for power purposes. A total gross head of 138 feet could be developed between a maximum pool elevation of 1,058 and a tailwater elevation of 920 at the power house located at the downstream toe of the dam. Generating facilities for 6,000 kilowatts would be provided in the power house. The plant would produce about 5.4 million kilowatt-hours annually at a capacity factor of about 10 percent. The project including flood control and hydroelectric power is estimated to cost $12.2 million and have a benefit-cost ratio of 0.6 to 1. A project considering flood control alone would cost about $4.7 million and have a benefit-cost ratio of 0.5 to 1.

5. WILD RIVER DAM AND RESERVOIR

The dam site is located in the White Mountain National Forest, on the Wild River about 4 miles above its confluence with the Androscoggin River in the township of Batchelders Grant, Maine. The project constructed for flood control alone would require a rolled earth dam about 1,300 feet long and 125 feet high. The dam would provide 15,700 acre-feet of flood control storage to control 6 inches of runoff from the tributary drainage area of 49 square miles. Spillway crest would be at elevation 960 and the top of the dam at elevation 975 feet, above mean sea level. A secondary road within the reservoir area would be relocated outside the limit of the full flood pool. To include hydroelectric power in the project, the top of the dam would be at elevation 1,015 and the crest of the spillway at elevation 1,000. The reservoir would provide flood control storage of 15,700 acre-feet, and 13,400 acre-feet of storage for power purposes. A gross head of 113 feet could be developed between a headwater elevation of 953 and a tailwater elevation of 840 at the power plant located at the downstream toe of the dam. Generating facilities for 6,000 kilowatts would be installed in the powerhouse and would produce about 5.0 million kilowatt-hours annually at a capacity factor of about 10 percent. The multiple-purpose project is estimated to cost $8.2 million and have a benefit-cost ratio of 0.9 to 1.0. A project constructed for flood control alone would cost approximately $3.2 million and have a benefit-cost ratio of 0.6 to 1.0.

6. ELLIS RIVER DAM AND RESERVOIR

The Ellis River dam site is located on the Ellis River approximately one mile above its confluence with the Androscoggin River in the town of Rumford, Maine. The project was studied for flood control alone and for flood control in combination with recreation and hydroelectric power. None of the studied plans is economically justified at this time. An elevation of 660 was determined as being the maximum permissible pool surface to prevent flooding in the communities of Andover and East Andover, Maine. The following subparagraphs briefly describe the projects studied.

a. Flood Control Only. The project would consist of a rolled earth dam approximately 800 feet long, a maximum height of 56 feet, and a top elevation of 671. A rolled earth dike about 2,500 feet long and 36 feet high would be required to close a saddle in the perimeter of the reservoir. A chute type spillway 450 feet long with crest at elevation 651 and gated outlet works would also be provided. The reservoir impounded by the dam would have a flood control storage of 70,000 acre-feet equivalent to 8 inches of runoff from the tributary drainage area of 164 square miles. The total cost of the project is estimated to be $6.3 million, with a benefit-cost ratio of 0.8 to 1.

b. Flood Control and Recreation. This project is similar to the project described above except that the elevation of the top of the dam, dike, and crest of spillway are each increased by 8 feet, and the length of the dam and dike are increased by 50 and 380 feet, respectively. A weir with crest at elevation 642 would also be required for the regulation of the recreation pool. The reservoir would provide a storage of 70,000 acre-feet for flood control and 40,000 acre-feet for recreation. The total cost of the project is estimated to be $7.3 million, with a benefit-cost ratio of 0.8 to 1.

c. Flood Control, Recreation and Hydroelectric Power. The project would require a rolled earth dam approximately 860 feet long, at a maximum height of 65 feet, and a top elevation of 680. The dike would be about 2,900 feet long and 45 feet high. A chute type spillway would be 450 feet long and have a crest elevation of 660. A reservoir regulating structure would be provided at the upstream toe of the dam. The reservoir would provide a flood control storage of 70,000 acre-feet, and 43,000 acre-feet for power purposes. A gross head of 28 feet would be developed between a pool elevation of 643 and a tailwater elevation of 615 at the power plant located at the downstream toe of the dam. Generating facilities for 5,000 kilowatts would be installed in the power house that would produce about 4.0 million kilowatt-hours of energy annually at a capacity factor of about 10 percent. The total cost of the project is estimated to be $10.3 million, with a benefit-cost ratio of 0.8 to 1.

d. Change in Hydraulic Analyses. There are no official records of flow on the Ellis River. Therefore, the discharge data available for the Swift River - a tributary of the Androscoggin River approximately 7 miles to the east of and paralleling the Ellis River - was assumed applicable for the study of this project. Upon completion of preliminary investigations, it appeared that the project should be studied further because of the relatively high degree of economic feasibility. During a field survey of the project area, local residents questioned the value of a flood control reservoir on the Ellis River. It was their opinion, based on observation, that the rapid rise of flood waters on the Androscoggin River produced reverse flow in the lower Ellis River, thereby reducing the Ellis River contribution to the main river flood. Since the discharge reductions assigned to a reservoir determines its economic feasibility, further study on the project was deferred until more field data could be obtained to determine the flood hydraulics of the lower Ellis River. This phenomenon is further described in paragraph 11a of Appendix B.

7. RUMFORD DAM AND RESERVOIR

The Rumford project was investigated for flood control alone and for multiple-purpose use including power and recreation. The dam site is located on the Androscoggin River 93 miles above its mouth in the town of Rumford, Maine. The project constructed for flood control alone would require a structure consisting of a concrete spillway 1,400 feet long and rolled earth abutments. The overall length of the structure would be approximately 1,620 feet. The crest of the spillway would be at elevation 652, and the top of the dam would be at elevation 670 with a maximum height of 62 feet. The reservoir created by the structure would be approximately 20 miles long and would impound 237,000 acre-feet of flood control storage to control 4.5 inches of runoff from the net tributary drainage area of 988 square miles below Errol Dam. A dike, having an overall length of 3,000 feet and a maximum height of 35 feet, would be required to close a saddle in the perimeter of the reservoir. Bedrock is not available at the dam site. The reservoir area consists of farmland and woodland. Approximately 22 miles of highways and 7 miles of secondary roads would require relocation and/or raising. About 2 miles of railroad track would also require raising. There are approximately 270 buildings within the full flood pool area including 3 churches and 5 schools. Two cemeteries containing approximately 2,000 graves require relocation. The modifications required in the project to provide hydroelectric power and recreation would include increasing the height of dam to elevation 693 and crest of spillway to elevation 675. A storage of 316,000 acre-feet, equivalent to 6 inches of runoff from the tributary drainage area, would be provided for flood control and 344,000 acre-feet for power purposes. A gross head of 49 feet would be developed at the power plant located at the toe of the dam. Generating facilities of 56,250 kilowatts in the power house would produce about 74 million kilowatt-hours annually at a capacity factor of about 10 percent. The multiple-purpose project is estimated to cost $57.5 million and have a benefit-cost ratio of 0.8 to 1.0. The project for flood control alone would cost $20.7 million and have a benefit-cost ratio of 0.7 to 1.0.

8. ROXBURY DAM AND RESERVOIR

The Roxbury project was investigated for flood control only. The dam site considered for this report is located in the town of Roxbury, on the Swift River about 11 miles above its mouth. The dam approximately 2,000 feet long, with a maximum height of 112 feet would impound 36,300 acre-feet of flood control storage to control $8\frac{1}{2}$ inches of runoff from the tributary drainage area of 80 square miles. The crest of the spillway would be at elevation 810 mean sea level, and the top of the rolled earth dam at an elevation of 830. The reservoir area includes woodland, farmland, and approximately 20 houses. One road, Route 16, would require relocation and raising. The total cost of the project is estimated to be $5.0 million. The benefit-cost ratio is about 0.7 to 1.0.

9. DIXFIELD DAM AND RESERVOIR

The dam site is in the towns of Mexico and Dixfield, Maine on the Webb River approximately 1.3 miles above its mouth. The project, considered for flood control alone, would require a rolled earth dam approximately 3,080 feet long, 66 feet high with top at elevation 486, above mean sea level; a concrete spillway with crest at elevation 456; and gated outlet works. The reservoir at spillway crest would be about 6 miles long, have a surface area of 2,750 acres, and a gross storage capacity of 55,500 acre-feet, equivalent to 8 inches of runoff from the drainage area of 130 square miles. The reservoir area includes, swampland, woodland, farm land, and 12 buildings including one school house. Route 142 and two secondary roads would require relocation. The inclusion of hydroelectric power to the project would require a dam with top at elevation 530, crest of spillway at elevation 500, and reservoir storage of 55,500 acre-feet for flood control purposes and 151,500 acre-feet for power purposes. A gross head of 64 feet could be developed between a headwater elevation of 484, and a tailwater elevation of 420. Generating facilities for 8,000 kilowatts, in a single unit, would be installed in the powerhouse located at the foot of the dam. The plant would produce about 7.2 million kilowatt-hours annually at a capacity factor of about 10 percent. The total cost of the multiple-purpose project is estimated to be $11.1 million. The benefit-cost ratio is about 0.5 to 1.0. For flood control alone, the total estimated project cost is $3.3 million and the benefit-cost ratio is about 0.6 to 1.0.

10. TURNER DAM AND RESERVOIR

This project is also known as Buckfield Dam and Reservoir in the 1938 survey report and the New England-New York Inter-Agency Committee report of 1955. The project was considered for flood control and hydroelectric power for this report. The dam site would be located on the Nezinscot River in the town of Turner, Maine. As a flood control project, the rolled earth dam, approximately 1,280 feet long including a concrete spillway 547 feet long, would have a maximum height of 58 feet and a top elevation of 360 feet above mean sea level. The spillway with crest at elevation 340 and gated outlet works would be located in the south abutment of the dam. The reservoir at spillway crest would extend up the Nezinscot River about 6.4 miles, up Martin Stream 6.8 miles, and up Bog Brook 3.2 miles, and would have a surface area of 3,360 acres. The reservoir would have a flood control storage capacity of 49,400 acre-feet equivalent to 6 inches of runoff from the tributary drainage area of 155 square miles. The reservoir area consists of swamp, woodland, and farm lands. Routes 4 and 117 and three secondary roads require relocation and raising. Nine buildings, two schools, and one cemetery are within the reservoir area. The modifications required in the project to provide hydroelectric power would include an increase in height of the dam to elevation 370, and crest of spillway to elevation 350. The reservoir would provide for flood control storage of 49,400 acre-feet, equivalent to 6 inches of runoff from the tributary drainage of 155 square miles, and 34,100 acre-feet of storage for power purposes. A gross head of 34 feet could be developed between a headwater elevation of 336 and a tailwater elevation of 302. Generating facilities for 5,000 kilowatts would be installed in the power house located at the downstream toe of the dam. The plant would produce about 4.7 million kilowatt-hours annually at a capacity factor of about 10 percent. The total cost of the multiple-purpose project is estimated to be $7.3 million, and the benefit-cost ratio is 0.5 to 1. For flood control alone, the total estimated project cost is $3.56 million and the benefit-cost ratio is 0.4 to 1.

PART II - LOCAL PROTECTION PROJECTS

11. INTRODUCTION

The following paragraphs present brief descriptions of local protec-protection sites investigated but not recommended at this time since studies indicate that flood damages preventable by the construction of the projects are insufficien to justify the projects. Protection at Gorham, New Hampshire and Norway and Mexico, Maine was also previously investigated under Section 205 of Public Law 87-874 and found not economically feasible. Pertinent data regarding local protection projects studied but not recommended is summarized in Table I-2 at the end of this appendix.

12. BERLIN, NEW HAMPSHIRE

The Dead River, a small tributary flowing through the city of Berlin, has caused considerable damage in past floods. Losses of $50,000 were sustained by business properties in the flood of March 1936. Since the river is confined to a conduit constructed under buildings in the city, protection by means of dams and reservoirs above the community on the Dead River and Jericho Brook was considered to be the most feasible solution to the flood problem. However, the cost of such work is not justified at this time.

13. GORHAM, NEW HAMPSHIRE

This community, vulnerable to floods from the Androscoggin, Moose and Peabody Rivers, suffered losses of $39,000 in the flood of March 1936. Gorham is located along the right bank of the Androscoggin River and is bordered by Moose Brook and the Moose River on the upstream end and the Peabody River on the downstream end of the community. Two flood-prone areas were studied for protection; one located between Moose Brook and the Moose River and the other between the Moose and Peabody Rivers. The former area could be protected by the construction of 2,600 feet of earth dike and pumping facilities, and the latter area by 9,500 feet of earth dike, a pressure conduit, and pumping facilities. A plan to divert Moose Brook and Moose River to the Androscoggin River upstream from Gorham was found to be more costly than protection by earth dikes. At this time, local protection works are not economically feasible at these locations.

14. RUMFORD, MAINE

The community of Rumford suffered flood losses of $894,000 in March 1936. The area investigated for local protection works is located between the Oxford Paper Company plant and Androscoggin River and would consist of pumping facilities, and 1,450 lineal feet of concrete flood wall constructed at the downstream end of an existing earth dike. At the present time, Federal participation in this work is not warranted. An alternative method of providing local protection work was to divert the floodwaters from above the community into a new channel and/or tunnel to the Androscoggin River below Rumford. This method of providing flood protection was also found to be not economically justified at this time. Consideration was given to removing Wheeler Island, just upstream of Logan Brook, which is reported to be the cause of ice jams backing up all the way to Rumford Center. This was likewise found to be economically infeasible.

15. MEXICO, MAINE

The community of Mexico is located on the left bank of the Swift and Androscoggin Rivers. The flood losses in the community amounted to $442,000 in March 1936, with the losses sustained mostly by residential and commercial properties. Local protection could be provided by the construction of 2,400 feet of earth dike, 350 feet of concrete flood wall, and pumping facilities, but the cost of such work is not economically justified at this time.

16. WAYNE, MAINE

Nearly every spring, the high water on the Androscoggin River backs up the Dead River into Androscoggin Lake, raising the level of the lake 12 to 15 feet. During the record flood of March 1936, the surface rose about 25 feet, flooding residential and commercial properties in Leeds Center and Wayne, and many summer homes on the shore of the lake. The flood damages amounted to approximately $40,000. A dam with flap gates was constructed near the mouth of the Dead River in 1933 to prevent high water on the Androscoggin River from flowing into Androscoggin Lake, but the dam was of insufficient height, and high flows (10 feet or more above low water) overtop the structure. Protection against flooding of properties in this region could be provided by constructing a new and higher dam on the Dead River, but costs of such works are not economically justified at this time. Since the storage of flood waters afforded by the lake has a marked influence on downstream flood heights, an equal amount of storage at some other location is required if a new structure for flood control is constructed.

17. LEWISTON, MAINE

Damage by floods in Lewiston amounted to $367, 500 in March 1936. Local protection was investigated and studied for three flood-prone areas, one immediately upstream of the Maine Central Bridge, the second from the Union Water Power Company Dam to the Grand Trunk Railroad Bridge, and the third from and including the canal at the end of Chestnut Street to about 500 feet downstream of Gully Brook. Protection against flooding could be provided by the construction of 1, 830 feet of earth dike and 150 feet of concrete floodwall in the upper area, 1, 170 feet of concrete floodwall and 1, 240 feet of earth dike for the middle area, and 2, 850 feet of concrete floodwall and 1, 310 feet of earth dike for the lower area. Pumping and drainage facilities would be required for each area. Studies on these areas indicated that the construction of local protection works for a single area or any combination thereof is not economically feasible at this time.

18. AUBURN, MAINE

The flood damage in this city amounted to $540, 500 in March 1936. The major portion of the damage was sustained by industrial and commercial establishments located along the Androscoggin River. Protection against flooding was studied for two flood-prone areas. Flood protection for one area, extending downstream from the Maine Central Railroad Bridge to about 1, 100 feet below North Bridge near the river end of Drummond Street, could be provided by the construction of 1, 930 feet of concrete floodwall, 380 feet of earth dike, a pressure conduit, two pumping stations, and appurtenant drainage facilities. Flood protection for the second area, just downstream from the Little Androscoggin River, could be provided by construction of 1, 600 feet of concrete floodwall, 490 feet of earth dike, a pumping station, and appurtenant drainage facilities. However, the costs of such works were found to exceed the benefits.

19. LISBON FALLS, MAINE

The mill buildings of the Worumbo Division of J. P. Stevens and Company, Incorporated, and the U. S. Gypsum Company in the community of Lisbon Falls have been badly damaged by past floods on the Androscoggin River. Losses of $800,000 were experienced in the flood of March 1936. Flood protection could be provided by the construction of floodwalls, pumping stations, dikes, canal control structures, and removal of an existing dam, but such works are not justified at this time.

20. TOPSHAM, MAINE

Consideration was given to the possibility of providing local protection works along the low left bank of the Androscoggin River above the lower highway bridge in the community of Topsham. The flood-prone area is occupied by the mill buildings of the Pejepscot Paper Division of the Hearst Publishing Company, Incorporated. The losses experienced in the flood of March 1936 amounted to $291,000. Protection could be provided by floodwalls, dikes, canal control structure, and pumping facilities. This work is not economically feasible at this time.

21. BRUNSWICK, MAINE

The community of Brunswick is located at the head of tidewater in the Androscoggin River. During the flood of March 1936 the community sustained losses of $435,000. The magnitude of these losses was principally due to high water elevations caused by ice jams which formed at ledge outcrop constrictions in the river channel. Although a reduction in flood damage is not economically feasible at this time, these losses could be reduced by the removal of ledge outcrops in and immediately below the community in the area known as the "Narrows".

TABLE I-1

RESERVOIRS STUDIED BUT NOT RECOMMENDED

PERTINENT DAM AND RESERVOIR DATA

Reservoir	Purpose	Drainage Area (sq. mi.)	Storage-acre-feet: Flood Control	Storage-acre-feet: Power & Recreation	Gross Head (Ft.)	Installed Capacity (kw)	Avg. Annual Generation (million kwh)	Project Cost ($1,000)	Annual: Costs ($1,000)	Annual: Benefits ($1,000)	B/C Ratio
Dead R., N.H.	F.C.	15	6,400	-	-	-	-	3,500	132	26	0.2
Moose R.	F.C.	20	8,500	-	-	-	-	1,800	73	40	0.6
Moose R.	F.C. & Power	20	8,500	2,900	72	1,500	1.3	3,600	150	106	0.7
Peabody R.	F.C.	43	18,500	-	-	-	-	4,700	173	81	0.5
Peabody R.	F.C. & Power	43	18,500	16,500	138	6,000	5.4	12,200	458	280	0.6
Wild R.	F.C.	49	15,700	-	-	-	-	3,200	128	77	0.6
Wild R.	F.C. & Power	49	15,700	13,400	113	6,000	5.0	8,200	318	274	0.9
Ellis R.	F.C.	164	70,000	-	-	-	-	6,300	245	203	0.8
Ellis R.	F.C. & Rec.	164	70,000	40,000	-	-	-	7,300	280	222	0.8
Ellis R.	F.C. & Power & Rec.	164	70,000	43,000	28	5,000	4.0	10,300	400	330	0.8
Hale, Swift R.	F.C.	111	47,400	-	-	-	-	8,700	313	183	0.6
Hale, Swift R.	F.C. & Power & Rec.	111	47,400	284,600	250	33,750	31.0	31,100	1,193	912	0.8
Rumford	F.C.	988	237,000	-	-	-	-	20,700	780	520	0.7
Rumford	F.C. & Power	988	316,000	344,000	46	56,250	74.0	57,500	2,280	1,856	0.8
Roxbury, Swift R.	F.C.	80	36,300	-	-	-	-	5,000	187	133	0.7
Dixfield, Webb R.	F.C.	130	55,500	-	-	-	-	3,300	130	77	0.6
Dixfield, Webb R.	F.C. & Power	130	55,500	151,500	64	8,000	7.2	11,100	430	229	0.5
Turner, Nezinscot	F.C.	155	49,400	-	-	-	-	3,560	142	57	0.4
Turner, Nezinscot	F.C. & Power	155	49,400	34,100	34	5,000	4.7	7,300	285	153	0.5

TABLE I-2

LOCAL PROTECTION PROJECTS STUDIED BUT NOT RECOMMENDED

PERTINENT DATA
(1964 Price Level)

Town or City	State	River	Approx. Total First Costs	Approx. Annual Charges	Approx. Annual Benefits	Approx. Benefit-Cost Ratio
Berlin	New Hampshire	Dead	$ 1,000,000	-	$ 100,000 *	-
Gorham, Dikes	New Hampshire	Androscoggin	1,100,000	44,000	3,000	0.1
Gorham, Diversion	New Hampshire	Androscoggin	1,500,000	60,000	-	-
Rumford, Dikes	Maine	Androscoggin	500,000	-	334,000 *	-
Rumford, Tunnel Diversion	Maine	Androscoggin	11,000,000	-	1,900,000 *	-
Mexico	Maine	Swift and Androscoggin	690,000	27,000	13,500	0.5
Wayne	Maine	Dead	300,000	-	276,000 *	-
Lewiston	Maine	Androscoggin	2,100,000	84,000	24,000	0.3
Auburn, above Little Androscoggin	Maine	Androscoggin	1,100,000	44,000	8,000	0.2
Auburn, below Little Androscoggin	Maine	Androscoggin	800,000	32,000	3,000	0.1
Lisbon Falls	Maine	Androscoggin	1,100,000	40,000	16,000	0.4
Topsham	Maine	Androscoggin	1,800,000	70,000	50,000	0.7
Brunswick	Maine	Androscoggin	1,700,000	-	700,000 *	-

* Total damages from a recurrence of 1936 flood.